Installation Manual

Turbec T100

Series 3

2.2T100S3_IMfro_rev02.fm

Turbec

Doc No. D12245-05

This document is valid for:

Series No/ Machine No Sign.

Turbec T100

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Turbec Spa
Via Statale 20/a
44040 Corporeno (FE)
Italy

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1. Introduction

To ensure maximum safety, always read the 2. *Safety precautions* chapter before doing any work on the equipment or making any adjustments.

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Equipment information

Purpose

The Turbec T100 microturbine system is modular system designed to generate power and heat. The T100 has several complementary modules to be used in a large amount of applications.

Turbec will not accept any liability for damage to equipment or injury to personnel caused by unauthorised or improper use of the Turbec T100 microturbine.

Module description

There are 4 different variants of the T100; 2 variants for indoor installation and 2 variants for outdoor installation.

T100 Power

The basic module is the T100 Power (T100 P), which produces electrical power. It is one complete module including the turbine, compressor, generator and recuperator. An external coarse pre filter, and an induced fan are also required for the installation.

T100 Power and Heat

The T100 Power and Heat unit (T100 PH) is the T100 P combined with an exhaust heat exchanger, which allows the machine to produce combined heat and power. The heat exchanger is delivered as a separate item, in addition to the T100 P, and installed directly to the exhaust gas outlet side of the T100 P.

T100 Outdoor installation

In case of an outdoor installation, an outdoor roof is mounted on the T100. The outdoor roof is delivered as a separate item. Besides the roof, a chimney (for the exhaust gases) is included in the scope of supply. In the outdoor installation, the coarse pre filter is included in the outdoor roof. The induced draft fan is also mounted directly on the T100.

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Manufacturer

This Turbec equipment has been manufactured by:

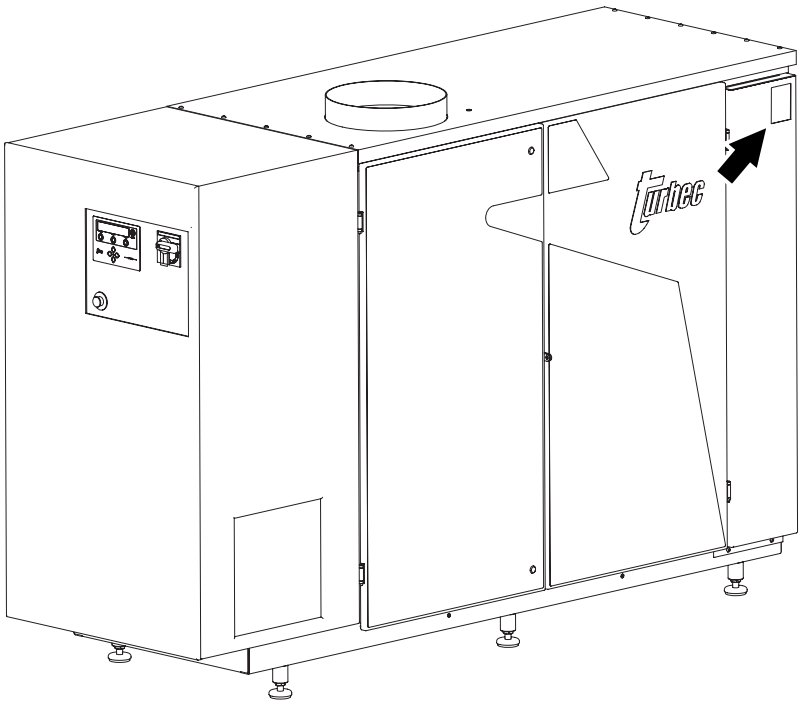
Turbec Spa
Via Statale, 20/a
44040 Corporeno (FE)
SE- 200 21 Malmö
Italy
www.turbec.com

For maintenance

Contact the nearest Turbec service station.

Identification

All machines have an equipment sign for identification of the machine. The sign is placed on the left side of the electrical cabinet.



Note! The picture above with the machine sign position shows the Turbec T100 P.

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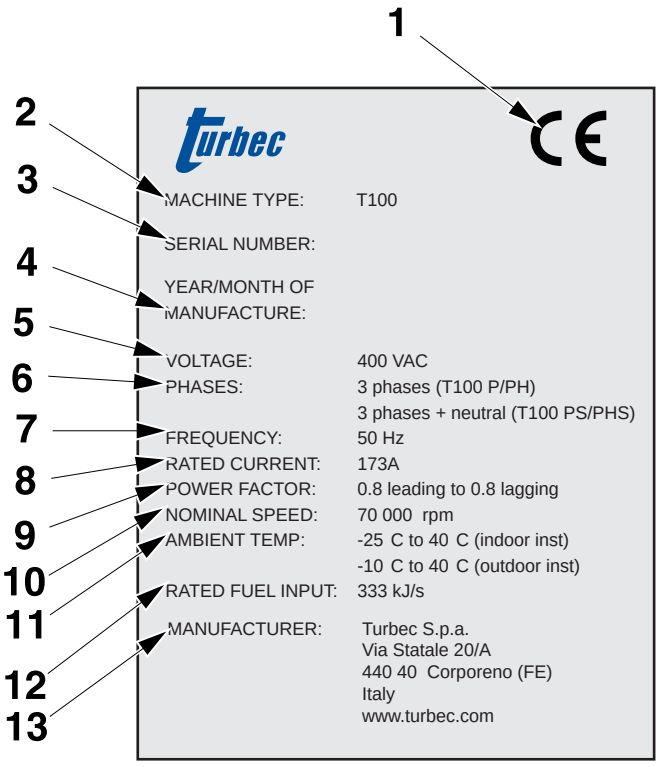
The figure below shows an example of the equipment sign. The sign contains data needed when contacting Turbec Spa concerning this specific equipment.



1 CE mark
2 Machine type
3 Serial number
4 Year and month of manufacture
5 Voltage
6 Phases
7 Frequency
8 Rated current
9 Power factor
10 Nominal speed
11 Ambient temperature
12 Rated fuel input
13 Manufacturer

CE marking

This equipment complies with the basic health, environment and safety regulations of the European Community and European Economic Area.

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Document information

Purpose of this Installation Manual

The purpose of this Installation manual is to provide technicians with information on how to safely install this Turbec equipment:
It is important to:

- keep the manual for the life of the equipment
- pass the manual on to any subsequent holder or user of the equipment

How to use this manual

This manual contains instructions for all different variants of the T100.

On the top of the pages a symbol is found to mark which variant/variants of the machine the instructions are valid for. If there is no symbol on the top of the page, the instructions apply to all variants.

Note! Some of the chapters have different sections for indoor and outdoor installation. This is only indicated in the head-line of the specific chapter.

P	T100 Power generation
PH	T100 Power and Heat
P PH	T100 Power generation T100 Power and Heat

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Design modifications

The instructions in this document are in accordance with the design and construction of the equipment at the time it was delivered from the Turbec manufacturing plant.

Technical publications

The technical publications for this equipment are:

- Installation Manual
- Maintenance Manual
- Operator's Manual
- Electrical Manual
- Spare Parts Catalogue

Updates and additional copies can be down-loaded at:

http//support.turbec.com.

To access the site, a log-in is needed. Contact Turbec Customer support for more information at:

Phone Helpdesk: +46 (0) 40 680 01 00
Fax:+46 (0) 40 680 00 01
Web site: www.turbec.com

When down-loading technical publications, always quote language and the machine serial number and version or the **document number** that can be found in the machine specification document.

Number of pages

This document contains a total of 154 pages.

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Nomenclature and abbreviations

The following nomenclature and abbreviations are used in the Installation manual.

AC	Alternating Current
Auxiliary system	Lubrication, water cooling, air cooling, buffer air are all auxiliary systems
CE	Conformité Européene
Coarse filter	A coarse filter placed at outside air intake
Control panel	User interface for controlling the T100 microturbine
DC	Direct Current
Enclosure	The enclosure is where all systems, except the evacuation fan, are installed in the T100 microturbine system
EMC	Electromagnetic compatibility
Evacuation fan	Ventilation fan which creates cooling and ventilation for the T100 enclosure
Fine filter	Fine air filter for combustion air
Fuel gas system	Piping and valves connecting the gas grid to the T100 microturbine.
Heat exchanger	Exhaust gas heat exchanger for generation of heated water
Housing	Includes compressor, the turbine and the generator
MCB	Main Circuit Breaker
PLC	Programmable Logic Controller
PMC	Power Module Controller
T100 P	T100 Power Generation
T100 PH	T100 Power and Heat Generation

Standard International System (SIS) abbreviations are used for most measurement

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2. Safety precautions

To ensure maximum safety, always read this section carefully before doing any work on the equipment or making any adjustments.

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2.1 Hazard information

2.1.1 General

DANGER!

Failure to observe information marked “DANGER!” **puts your life in danger**.

WARNING!

Failure to observe information marked “WARNING!” can result in **personal injury and/or serious damage to, or destruction of, equipment**.

Caution! Failure to observe information marked “Caution!” can result in **damage to equipment**.

2.1.2 Sign for mandatory actions

Disconnect voltage before any work

2.1.3 Warning signs

Hot surface

Dangerous voltage

General danger

Hanging load

Risk of crushing

Powerful magnetic field

Remote controlled machine start

Inflammable

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2.2 Personnel

Only skilled or instructed personnel are allowed to work on the equipment.

The manufacturer declines all responsibility for injury or damage if the instructions in this manual are not followed.

Personnel are responsible for:

- the equipment and the work area around the equipment
- all personnel in the vicinity of the equipment
- making sure that all safety devices are fully operational

Personnel must regard all electrical equipment as live. In general, switch off all electrical connections to the T100 before carrying out maintenance or repair work.

2.2.0.1 Electricians

Electricians should be certified according to local regulations and have experience of similar types of installations, proven skills in reading and working from drawings and cable lists, and knowledge of local safety regulations regarding power and automation. Work with the electrical equipment must be performed only by skilled or instructed technicians.

According to EN 60204-1, 3.28 an instructed person is:

– *An individual adequately advised or supervised by a skilled person to enable that individual to avoid hazards which electricity can create (e.g. operating and maintenance staff).*

According to EN 60204-1, 3.52 a skilled person is:

– *An individual with technical knowledge or sufficient experience to enable that individual to avoid hazards which electricity can create.*

2.2.0.2 Gas fitters

Gas fitters should be certified according to local regulations and have experience of similar types of installations, proven skills in reading and working from drawings and knowledge of local safety regulations regarding gas and automation. All work with the gas system should be conducted by locally approved gas fitters.

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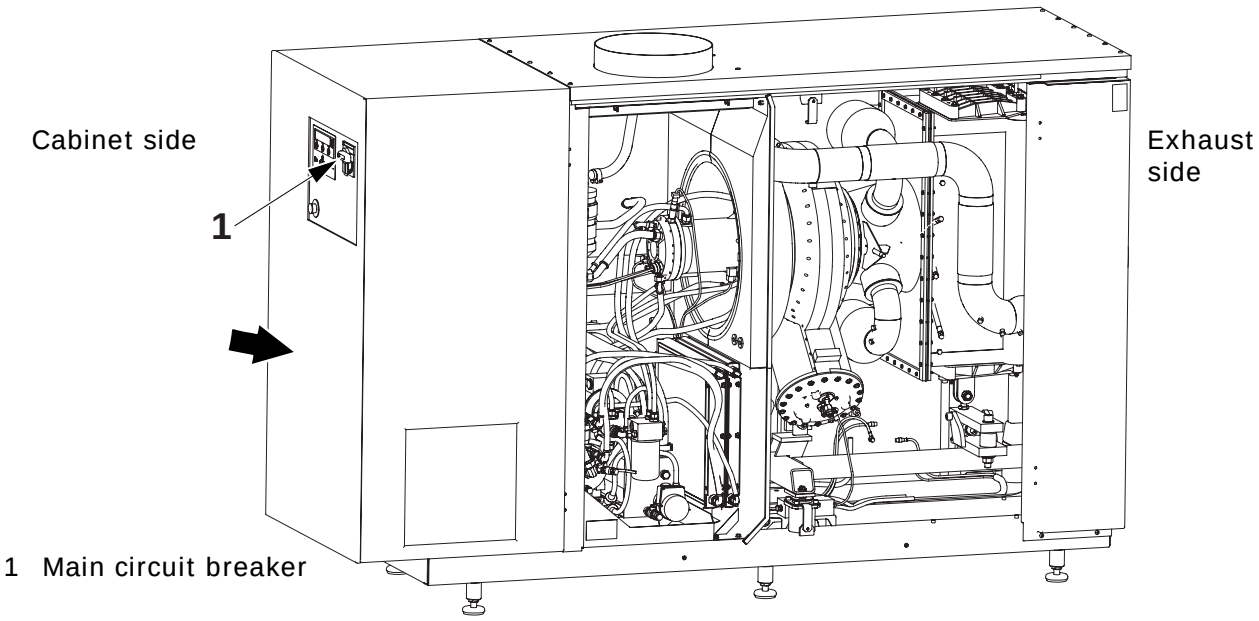
2.3 General safety precautions

2.3.1 Work inside the T100

The T100 microturbine's doors are locked with a standard key (Double bit 3 mm), and may only be opened by skilled or instructed persons.

Dangerous voltage

There are parts in the power electronics that hold high voltage (up to 600 VAC see arrows) Some parts remain live for up to 1 minute after the T100 microturbine's main circuit breaker (1) is switched off. In case of accident call for medical attention immediately.



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Note! The picture shows a T100 P.

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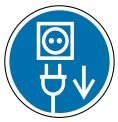

Work inside the T100 microturbine must be performed by skilled or instructed persons only. Before any work is done inside the T100 microturbine, always remember to:

a) Stop the T100, *see Operator's Manual, section: 3.2 Stopping the T100.*

b) Wait 10 minutes to cool down the T100.

c) Switch off the T100's main circuit breaker.

d) Switch off the external isolating switch for the grid network or remove fuses.

Note! The following instructions are just necessary for work inside the electrical cabinet.

e) Switch off the 24 VDC including the battery backup to the PMC.

f) Wait a minimum of 1 minute to allow the capacitors to discharge.

g) Remove, if necessary, protections.

h) Verify absence of voltage with a voltmeter.

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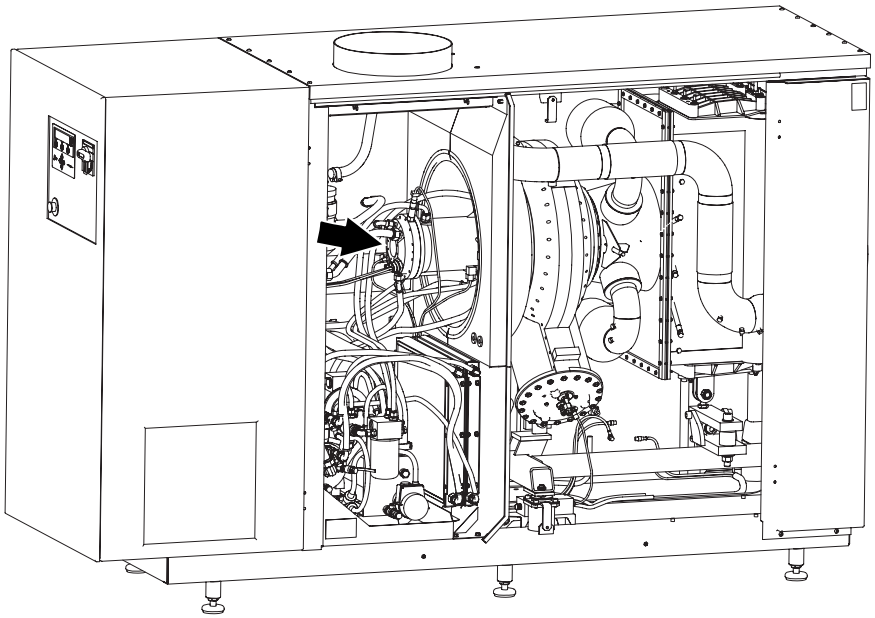
2.3.2 Generator

DANGER!

Dangerous voltage

During operation the voltage in the generator can be up to 600 VAC. The generator's location is shown by the arrow. In case of accident call for medical attention immediately.



Note! The picture shows a T100 P.

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2.3.3 Remote control

DANGER!

Remote controlled operation

The T100 microturbine can be remotely started, stopped and accessed from a supervision unit, via a modem or computer network or a Building Management System (BMS). To disable remote start of the T100, disconnect the T100 according to instructions (a)-(h) on page 13.

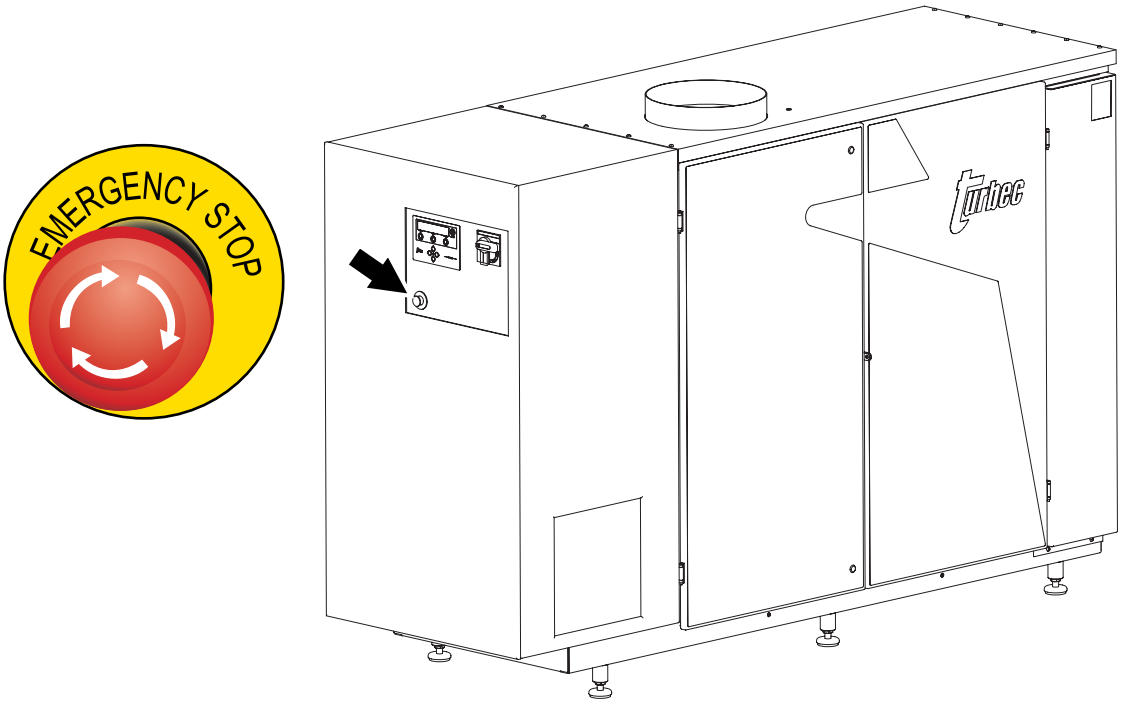
2.4 Machine safety device

2.4.1 Emergency stop button

Learn the position of the **Emergency stop** button in order to stop the equipment in case of danger to people or damage to the equipment.

Pushing the **Emergency stop** button will reset the equipment and shut off the fuel gas valves by a hard-wired loop thus stopping the engine. The electrical power output will cease, as the main contactor between the power electronics and the main circuit breaker will open.

Note! The Emergency stop shall never be used for normal shutdown. Emergency stopping may shorten the lifetime of the T100.



Note! The picture shows a T100 P.

2.4.2 Extra emergency stop

The T100 is prepared for an extra wall mounted **Emergency stop** button. This button is optional and should be located on a nearby wall. The function of the extra **Emergency stop** button is the same as the Emergency stop button on the T100.

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2.4.3 Doors and covers

WARNING!

Do not remove doors and covers

Make sure that all doors and covers are in place and functioning. Never remove covers while the equipment is in operation.

The T100 microturbine is protected by a pressure sensor to measure the negative pressure in the enclosure. This sensor is part of the safety system and must **never** be bridged, by-passed or otherwise made non-operational. Never stop the equipment by opening a door or cover!

Caution! Some parts of the equipment protected by doors and covers may be hot.

WARNING!

Do not walk on top cover

The top cover of the T100 microturbine is not designed to carry the weight of a person.
In case of accident, call for medical attention.

The T100 microturbine's doors are locked with a standard key (Double bit 3 mm), and may only be opened by skilled or instructed persons.

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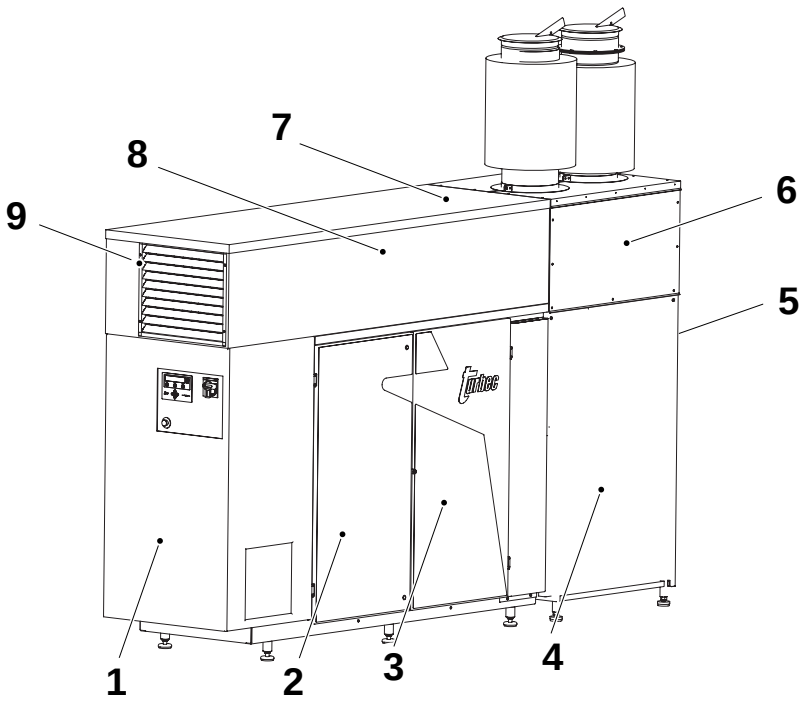
Service side view
1. Electrical cabinet door
2. Left front door
3. Right front door
4. Heat exchanger front cover
5. Heat exchanger right cover
6. Outdoor outlet front cover
7. Outdoor intake top cover
8. Outdoor intake front cover
9. Outdoor intake left cover



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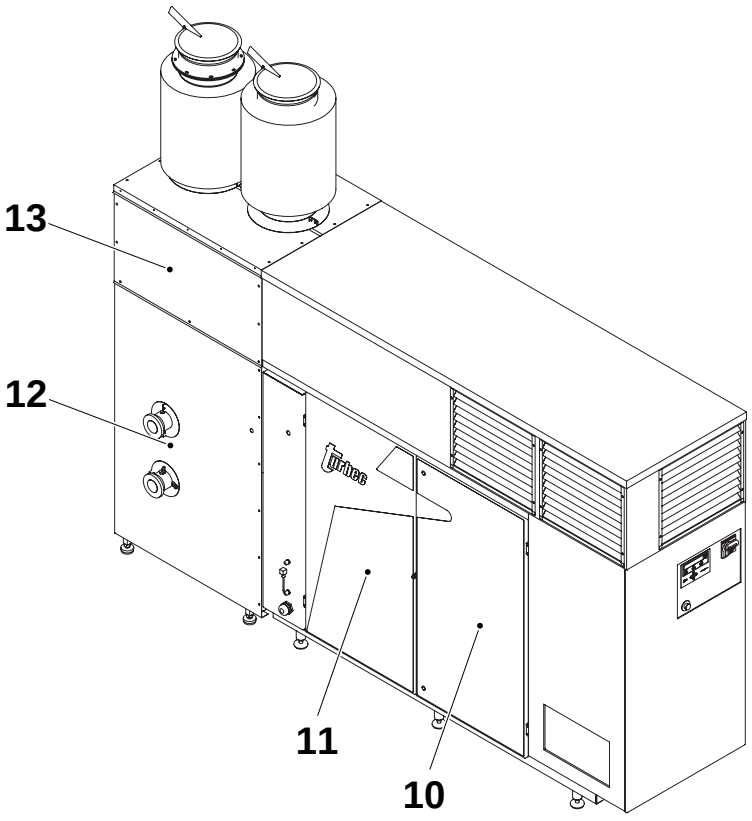
Back side view
10. Left back door
11. Right back door
12. Heat exchanger back cover
13. Outdoor outlet back cover



Note! The pictures shows sides of a T100 PH, outdoor installation.

2.5 Natural gas

WARNING!

Risk of personal injury!
Natural gas is asphyxiating and inflammable. Carefully follow the local instructions and gas regulations.

Follow the local regulations for handling of natural gas.

2.5.1 Classification

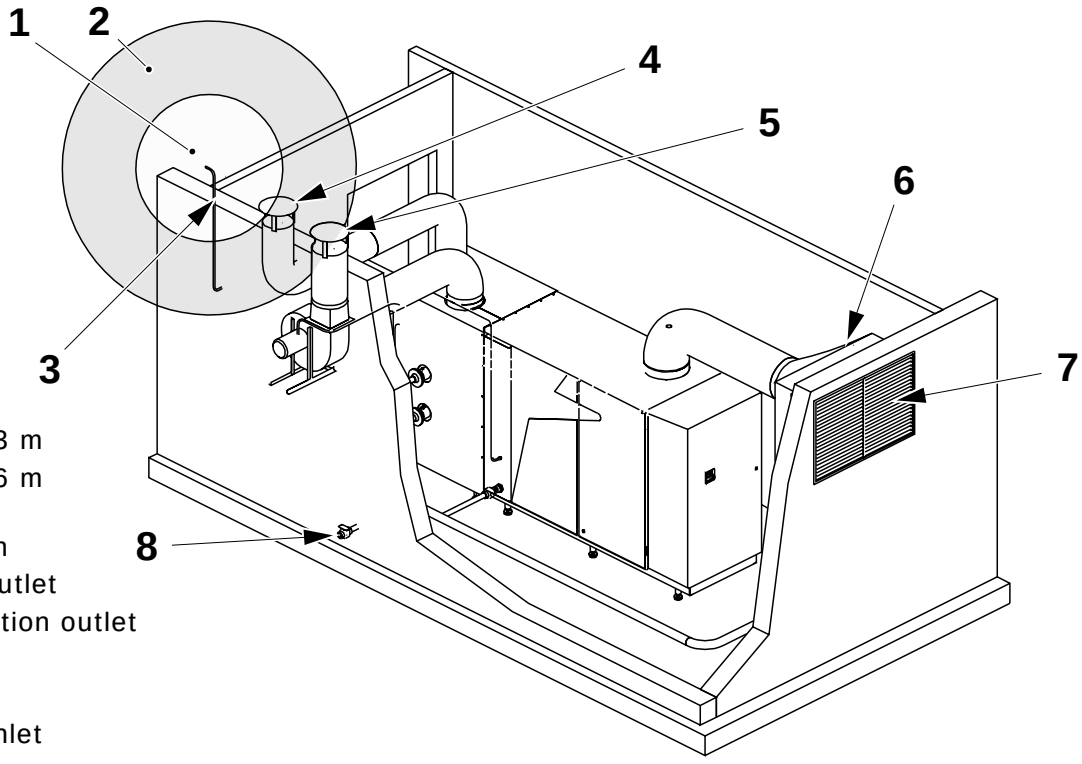
Gas group:	IIA
Temperature class:	T3

The T100 has been evaluated according to the ATEX directive. Due to the excessive ventilation, the calculations showed negligible size of zone 2 volumes in case of any leakage inside the T100. No means of ignition are close to the very small zones that can arise. The remaining installation is classified according to IEC/EN 60079-10 and has classified zones. The perimeter must be respected between the fuel gas evacuation and hazardous equipment.:

Zone 1:	ø3 m (ø9.8 ft)
Zone 2:	ø6 m (ø19.6 ft)

Note! The picture shows a typical indoor installation. The classified zones are also equivalent to outdoor installations.

Note! The air inlet must be installed in a non hazardous area.



1 Zone 1, ø3 m
2 Zone 2, ø6 m
3 Fuel gas evacuation
4 Exhaust outlet
5 Air ventilation outlet
6 Pre-filter
7 Air inlet
8 Fuel gas inlet

(Continued)

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(Continued)

2.5.1.1 Definitions (according to IEC/EN 6079-10):

Hazardous area:
An area in which an explosive gas atmosphere is present, or may be expected to be present, in quantities such as to require special precautions for the construction, installation and use of apparatus.

Zones:
Hazardous areas are classified into zones based upon the frequency of the occurrence and duration of an explosive gas atmosphere, as follows:

Zone 0:
An area in which an explosive gas atmosphere is present continuously or for long periods.

Zone 1:
An area in which an explosive gas atmosphere is likely to occur in normal operation.

Zone 2:
An area in which an explosive gas is not likely to occur in normal operation and, if it does occur, is likely to do so only infrequently and will exist for a short period only.

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2.6 Equipment for lifting and moving loads

WARNING!

Heavy load!
Make sure that the capacity of the lifting equipment is adequate and that the equipment itself is in good working order.

If lifting tackle has to be joined to make up the necessary lengths, make sure that the joints are secure and have the same lifting capacity as the rest of the tackle.

Always engage the safety clip on lifting hooks to prevent the tackle from slipping off.

Use ropes or poles to steady and manoeuvre loads. Do **not** use hands or feet.

Make sure that the route and the destination are free from obstacles before moving a suspended load. It must be possible to lower the load to the floor quickly and safely in an emergency.

When depositing loads, keep the lifting equipment in place until the stability of the load has been checked

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3. Drawings and Technical Data

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3.1 Installation drawings

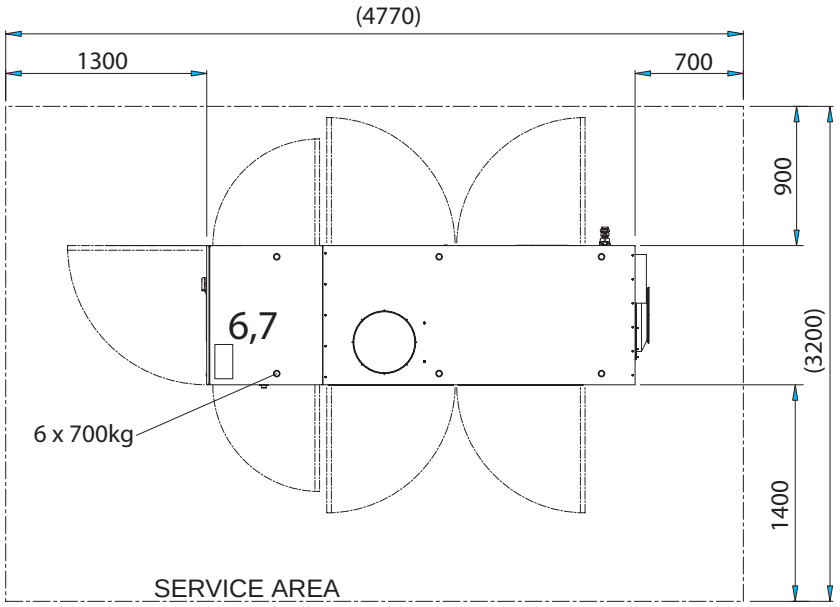
3.1.1 T100 P

The following drawings show machine dimensions, connection positions and dimensions, and access dimensions. All dimensions must be respected. All dimensions are in millimetres, and with inches in bracket, unless otherwise stated. Dimensions marked with * indicate inside width.

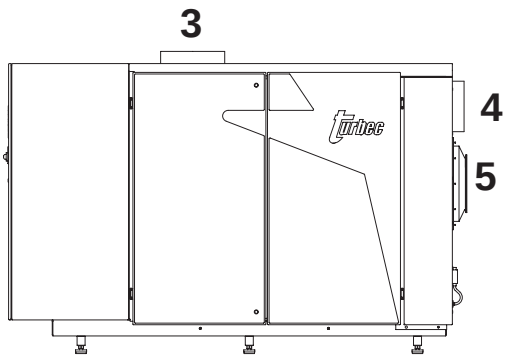
The following drawings are provided:

- Top view with marked service area
- Service side view
- Rear side view
- Top view
- Cabinet side view
- Outlet side view

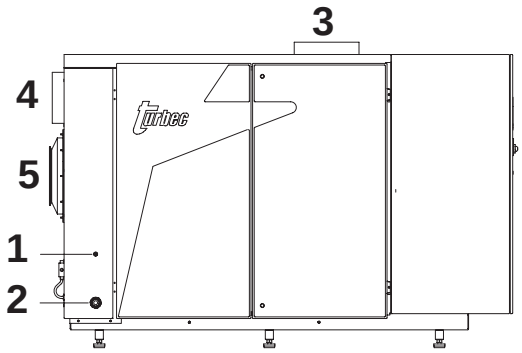
3.1.1.1 Top view with marked service area



3.1.1.2 Service side view



Back side view



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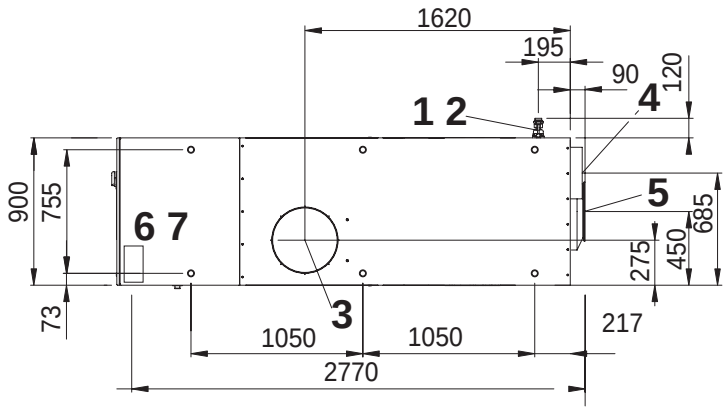
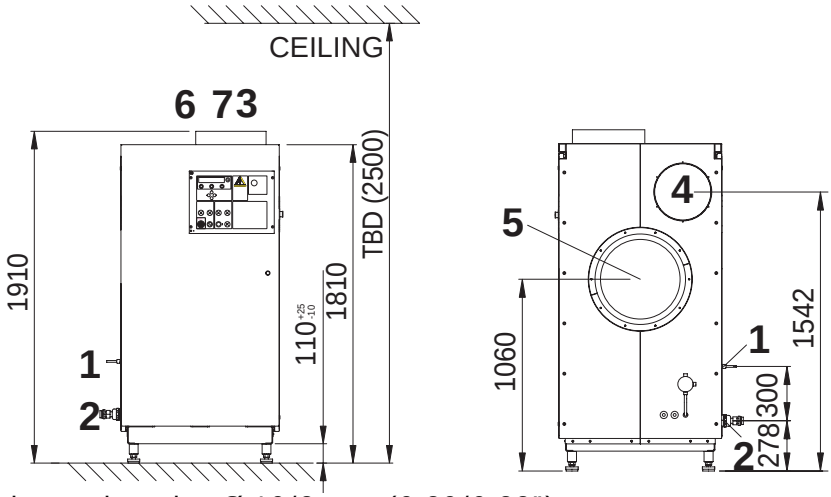
3.1.1.3 Top view



3.1.1.4 Cabinet side Outlet side



1 Fuel gas evacuation outlet, pipe Ø 10/8 mm (0.39/0.32”)
2 Fuel gas inlet, pipe 1 1/2” internal BSPP female thread
3 Pre-filtered air inlet, sleeve coupling male Ø 400 mm (15.75”) *
4 Ventilation outlet, sleeve coupling male Ø 315 mm (12.40”) *
5 Exhaust gas outlet, flange Ø 319 mm (12.55”) *
6 Grid cable
7 Electrical cables See *section 7. Electrical installation* for further information

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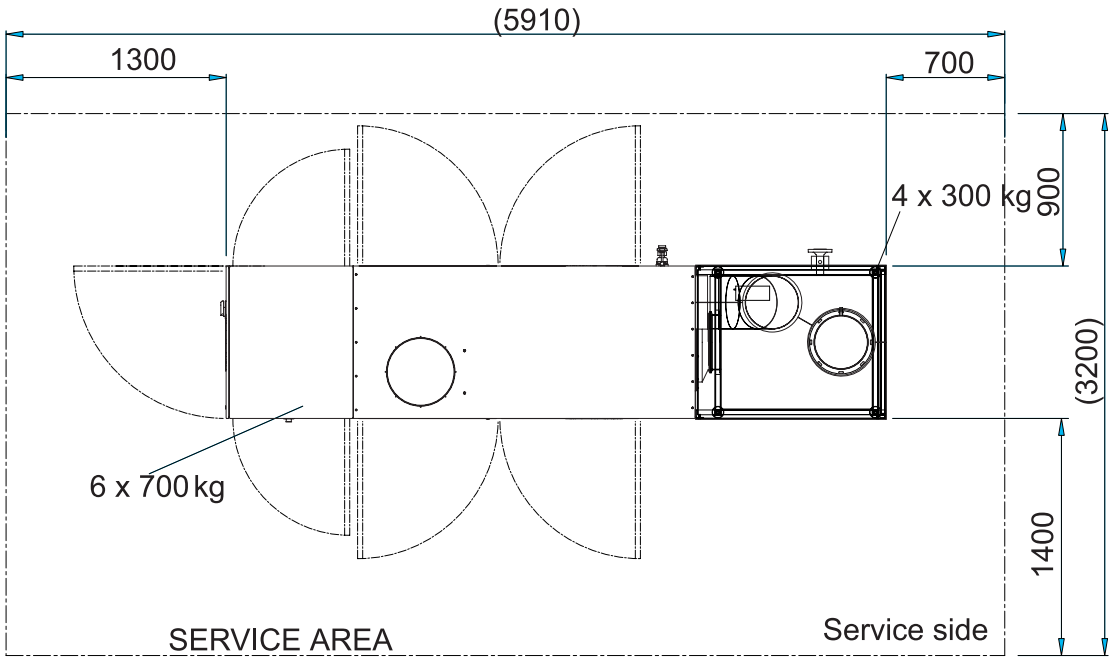
3.1.2 T100 PH

The following drawings show machine dimensions, connection positions and dimensions, and access dimensions. All dimensions must be respected. All dimensions are in millimetres, and with inches in bracket, unless otherwise stated. Dimensions marked with * indicate inside width.

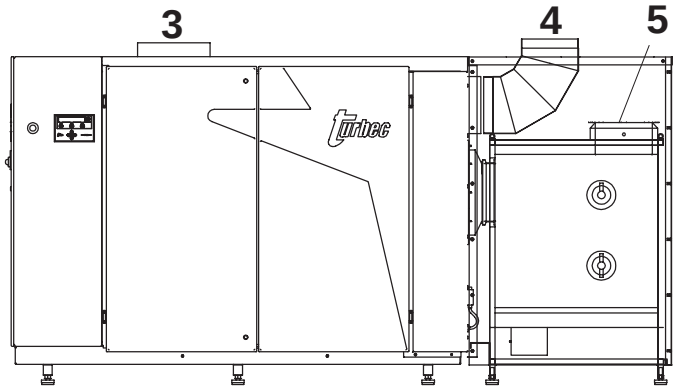
The following drawings are provided:

- Top view with marked service area
- Service side view
- Rear side view
- Top view
- Cabinet side view
- Outlet side view

3.1.2.1 Top view with marked service area

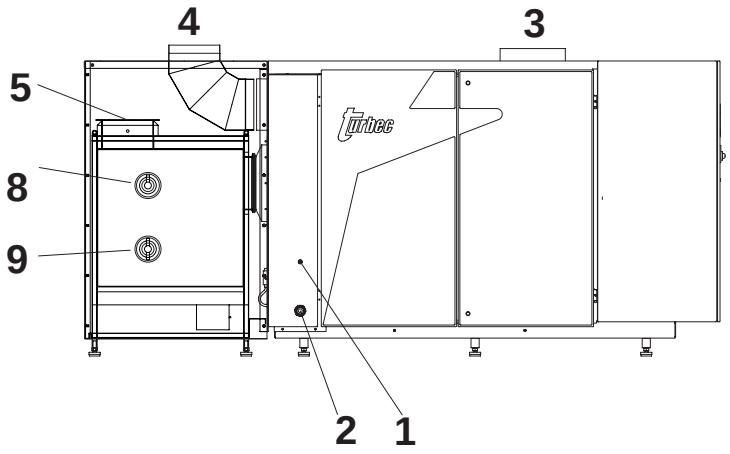


3.1.2.2 Service side view

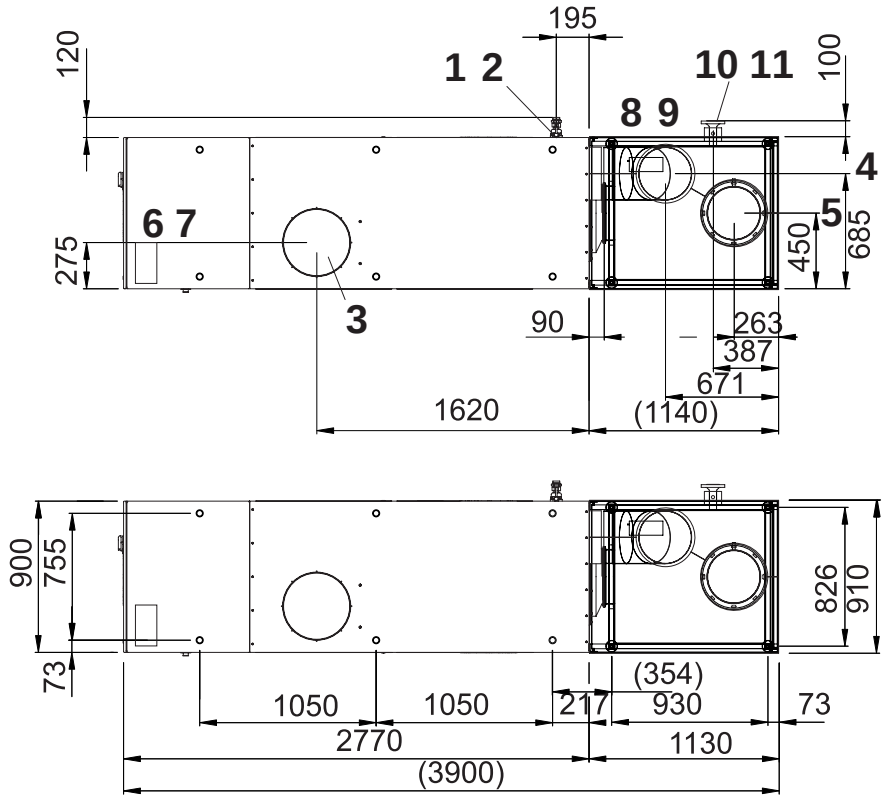


2.2T100s3_IM3_rev02.fm

3.1.2.3 Back side view

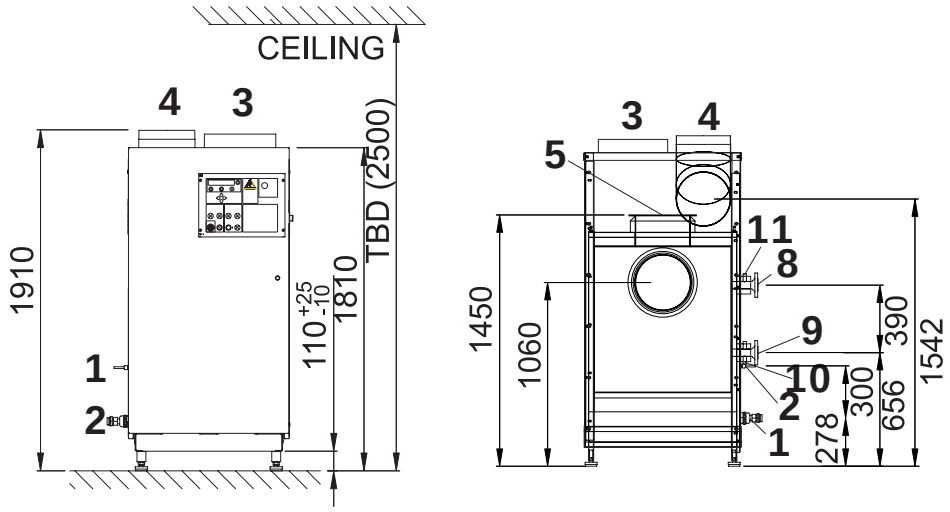


3.1.2.4 Top view



1 Fuel gas evacuation outlet, pipe Ø 10/8 mm (0.39/0.32”)
2 Fuel gas inlet, pipe 1 1/2” internal BSPP female thread
3 Pre-filtered air inlet, sleeve coupling Ø 400 mm (15.75”) *
4 Ventilation outlet, sleeve coupling Ø 315 mm (12.40”) *
5 Exhaust gas outlet, flange DN 315; DIN24154 (part 2&5)
6 Grid cable
7 Electrical cables See *section 7. Electrical installation* for further information
8 Water inlet, flange DN32 PN40; DIN2635 (1 1/4” 300Lbs; ANSI B16.5)
9 Hot water outlet, flange DN 32 PN40; DIN2635 (1 1/4” 300Lbs; ANSI B16.5)
10 Drain, heat exchanger
11 Air evacuation, heat exchanger

3.1.2.5 Cabinet side Outlet side



1 Fuel gas evacuation outlet, pipe Ø 10/8 mm (0.39/0.32”)
2 Fuel gas inlet, pipe 1 1/2” internal BSPP female thread
3 Pre-filtered air inlet, sleeve coupling male Ø 400 mm (15.75”) *
4 Ventilation outlet, sleeve coupling male Ø 315 mm (12.40”) *
5 Exhaust gas outlet, flange DN 315; DIN24154 (part 2&5)
6 Grid cable
7 Electrical cables See *section 3. Drawings and Technical Data* for further information
8 Water inlet, flange DN32 PN40; DIN2635 (1 1/4” 300Lbs; ANSI B16.5)
9 Hot water outlet, flange DN 32 PN40; DIN2635 (1 1/4” 300Lbs; ANSI B16.5)
10 Drain, heat exchanger
11 Air evacuation, heat exchanger

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3.1.3 Outdoor roof

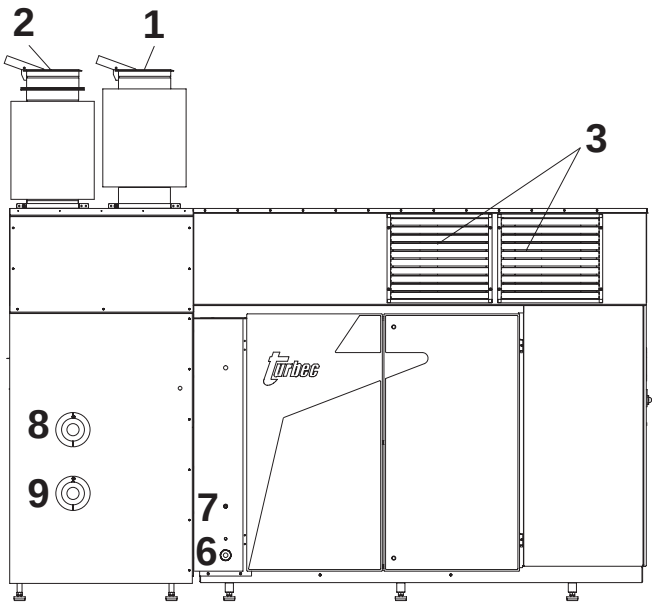
The following drawings show the outdoor roof dimensions, connection position and dimensions for the outdoor roof.

For information about other dimensions of the T100, *see section 3.1.1 T100 P* or *section 3.1.2 T100 PH*.

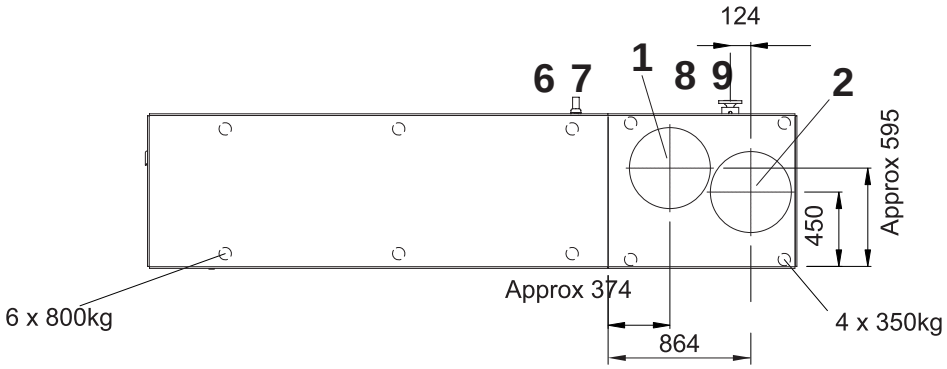
The following drawings are provided:

- Back side view
- Top view
- Cabinet side view

3.1.3.1 Back side view



3.1.3.2 Top view



1 Ventilation outlet
2 Exhaust gas outlet
3 Air inlet
4 Grid cable
5 Electrical cables See *section 7. Electrical installation* for further information
6 Fuel gas inlet, pipe 1 ½'' internal BSPP female thread
7 Fuel gas evacuation outlet, pipe Ø 10/8 mm (0.39/0.32")
8 Water inlet (T100 PH), flange DN32 PN40; DIN2635 (1 1/4" 300Lbs; ANSI B16.5)
9 Hot water outlet (T100 PH), flange DN32 PN40; DIN2635 (1 1/4" 300Lbs; ANSI B16.5)

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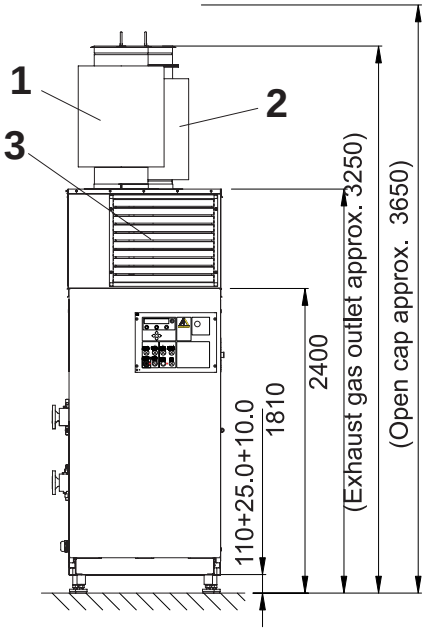
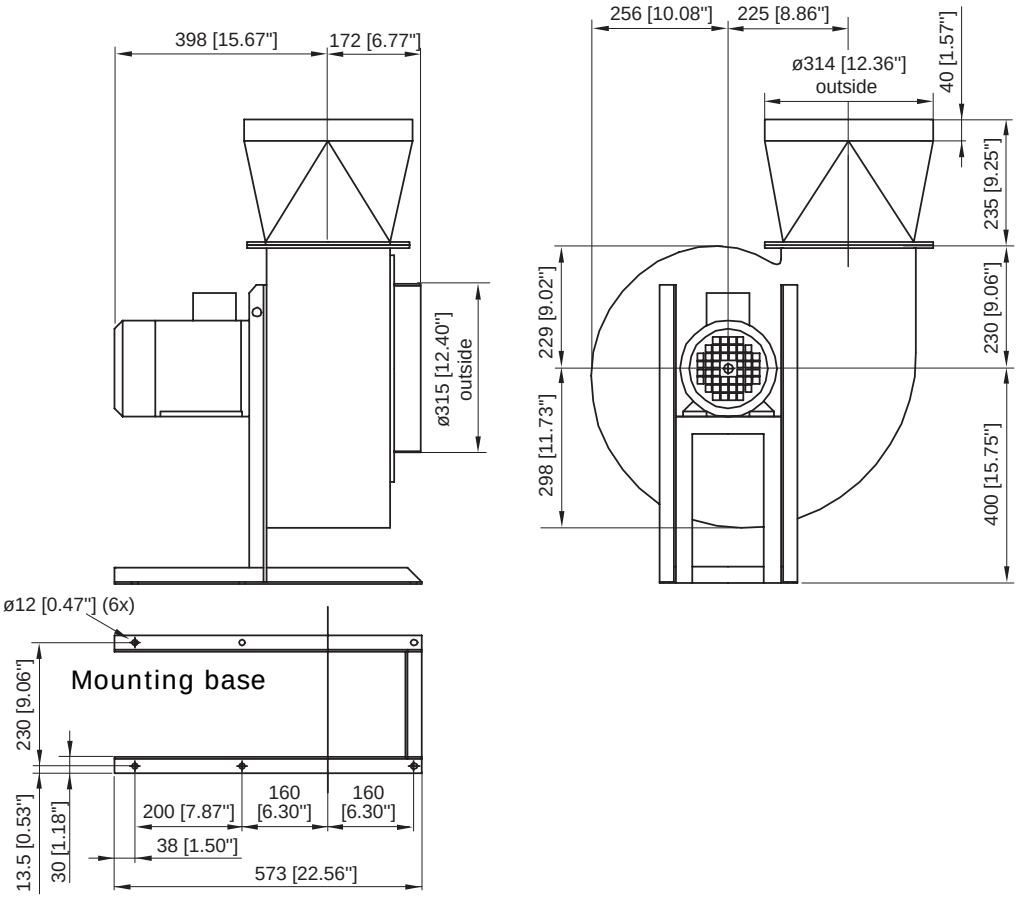
3.1.3.3 Cabinet side



1 Ventilation outlet
2 Exhaust gas outlet
3 Air inlet

3.1.4 Evacuation fan



2.2T100s3_IM3_rev02.fm

3.2 General identification

3.2.1 T100 P

Characteristics	metric
Model	T100 P
Type	Microturbine
Application	Power generation
Usage	Indoors or outdoors
Weight, indoor installation	2250 kg
Weight, outdoor installation	2750 kg
Site flooring	Hard floor
Fuel	Natural gas
Surrounding air temperature	-10°C to 40°C
Max. surrounding air humidity	100%

3.2.2 T100 PH

Characteristics	metric
Model	T100 PH
Type	Microturbine
Application	Combined Heat and Power
Usage	Indoors or outdoors
Weight, indoor installation	2770 kg
Weight, outdoor installation	3100 kg
Site flooring	Hard floor
Fuel	Natural gas
Surrounding air temperature	-10°C to 40°C
Max. surrounding air humidity	100% non-condensing

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3.2.3 Gas turbine

Characteristics	metric
Compressor type	Centrifugal
Turbine type	Radial
Type of combustion chamber	Lean pre-mix
Number of combustion chambers	1
Pressure in combustion chambers	4.5 bar (a)
Turbine inlet temperature	950°C
Number of shafts	1
Nominal speed	70 000 rpm

3.3 Noise

The table below shows the maximum noise level measurement for the T100 microturbine under the following conditions:

- Measurements on eight positions in accordance with ISO standard 3746
- Machine fitted with standard feet placed on a concrete floor
- Nominal operation, 100%, 70 000 rpm, 100 kW

These values are valid for indoor installation as well as for outdoor installation.

Characteristic	Symbol	Value	Rounded	notes
Emission sound pressure level	L_P	70 dBA	0.5 dB	1 m (3.3 ft) from T100 microturbine

3.4 Emissions

Characteristics	100% load	Notes
NO_x	< 15 ppm/v = 32 mg/MJ fuel	*
CO	< 15 ppm/v = 18 mg/MJ fuel	*
UHC	< 10 ppm/v	*

Note! * Volumetric exhaust gas emissions at 15% O_2 and 15°C air inlet.

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3.5 Inlet/outlet connection data

Characteristics	Metric	US measurements	Notes
Fuel gas pressure	0.02-1 bar (g)	0.3-14.5 psi (g)	Microturbine inlet
Fuel gas temperature	0°C to 60°C	32°F to 140°F	Microturbine inlet
Wobbe index	43-55 MJ/m_n^3	1 154-1 476 Btu/ scf	
Max air mass flow at 15°C (59°F)	1.69 kg/s (=1.38 m^3/s)	3.73lb/s (=48.7 ft^3/s)	
Air inlet temperature indoor installation	-25°C to 40°C	-13°F to 104°F	
Air inlet temperature outdoor installation	-10°C to 40°C	14°F to 104°F	
Max air inlet humidity	100%		Non-condensing
Max air particle size	1 mm		

3.5.0.1 Additional connection data for the Heat exchanger

Characteristics	Metric	US measurements	Notes
Water quality			
pH	6.5 - 8.0		
Max water pressure	24 bar (g)	348 psi (g)	
Max water volume flow	4 l/s	1.06 gal/s	
Min water volume flow	1.5 l/s	0.40 gal/s	
Min water inlet temperature	50°C	122°F	
Max water outlet temperature	150°C	302°F	
Total water volume of the Heat exchanger	18.6 l	4.91 gal	

3.6 Electrical power specifications

Characteristics	50Hz	Notes
Start-up voltage	400 VAC, 50 Hz	
Nominal voltage output	400/230 VAC, 3 phase	Neutral is not needed
Frequency output	50 Hz	
Rated current	173 A	
Max allowed mains frequency variations	± 5%	
Max allowed mains voltage variations	± 10%	
Adjustable power factor	0.80 leading to 0.80 lagging	May be limited by max apparent power
Harmonic current according to IEEE 519: Max total distortion Max single distortion	 5% 3%	
Output circuit	3 phase + safety ground	
Protection circuit	Short circuit protection Thermal over current protection	

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3.7 Auxiliary system

Cooling water specifications

Characteristics	Value	Notes
Water circuit volume	10 l (2.6 gal)	50% water / 50% glycol
Water quality		See Maintenance manual
Glycol	Texaco Havoline XLC +B	ASTM D3306, D4656, D4985
Consumption	0.5 litres/6 000 h (0.13 gal/6 000 h)	Add glycol 50%, see Maintenance manual

Lubrication oil specifications

Characteristics	Value	Notes
Oil circuit		
Max oil flow	Approx. 3.5 l/min (approx. 0.92 gal/min)	
Type	MIL-L-23699	See Operator's manual
Consumption	3 litres/6 000 h (0.80 gal/6 000 h)	

3.7.1 Gas fuel booster

Lubrication oil specifications

Characteristics	Value	Notes
Oil circuit		
Max oil flow	Approx. 5 l/min (approx. 1.32 l/min)	
Type	PAH compressor oil	See Operator's manual

Gas requirements

Characteristics	Value	Notes
Pressure min/max	0.02/1.0 bar (g) (0.3/14.5 psig)	With fuel booster
Temperature min/max	0°C/60°C (32°F/140°F)	

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4. Site preparation

2.2T100s3_IM4_rev02.fm

4.1 Installation preparations

Please ensure that the dimensions of the installation site and the positions of the connections comply with the values shown in the drawings, see *section 3. Drawings and Technical Data* and the *section 3.1 Installation drawings*.

Note! Check that the required service area as shown in the drawings, complies with the installation site. Check that the installation site is accessible for spare parts delivery.

Check that the specifications for T100 microturbine's connections comply with the Turbec Spa requirements. In case of doubt, please consult local technical personnel.

To find diagrams with correction of performance for T100 microturbine, see *Turbec Document D-12339 Technical Description, chapter 1.2.3. Correction of performance.*

Note! Check that the local legislation permits this type of microturbine installation, and in particular the fuel gas system and electrical grid connection. In case of doubt, please consult local authorities or local authorized technical personnel.

Please check the local legislation demands on personnel evacuation for the site.

It is possible to prepare parts of the installation of:

- Fuel gas
- Electricity
- Ventilation
- Hot water

before the main installation of the T100 microturbine is performed, see *section 6. Mechanical installation and connection* for more details.

If any specifications do not comply, please contact Turbec Spa for guidance and customizing.

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4.1.1 Installation preparations check list

Comments to the installation preparation check list are found in section *4.1.2 Comments to the Installation preparations check list.*

System	Checks	Remarks	Date/sign
Placement	Site access checked for the microturbine dimensions		
	Most narrow area to pass through with the T100 (L x W x H)	x x m	
	Available service area (L x W x H)	x x m	
	Available lifting device on site	Type:	
	Length of air supply ducts	m	
	Length of ventilation pipes	m	
	Length of exhaust gas pipes	m	
Fuel system	Fuel quality analysed or approved from supplier Make a note of: Lower Heating Value Quality fluctuations	MJ/Nm^3	
	Fuel supply piping ready to turbine hall Capacity and pressure levels are sufficient	bar (g)	
	Fuel supply connection size and type complies with counter flange described in section *6. Mechanical installation and connection*		
Electrical system	Connection points ready		
	Grid connection permit		
	Local requirements fulfilled		
	Equipment ordered		
	Cable route arranged all the way to the machinery		
	Cable area sufficient	mm	
	Cable length	m	
Air supply	Filter installed (indoor installation)		
	Air supply connection size and type complies with counter flange described in section *6. Mechanical installation and connection*		

(Continued)

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(Continued)

System	Checks	Remarks	Date/sign
Ventilation	Ventilation in the room (indoor installation) approved by local regulations		
	Ventilation connection size and type complies with counter flange described in section *6. Mechanical installation and connection*		
Exhaust gases	Stacks installed		
	Stacks ready to be connected to the microturbine		
	Exhaust connection size and type complies with counter flange described in section *6. Mechanical installation and connection*		
Hot water (T100 PH)	Connection flange ready to be connected to microturbine inlet flange		
	Connection flange ready to be connected to microturbine outlet flange		
	Water connection size and type complies with counter flange described in section *6. Mechanical installation and connection*		
Turbine room	Specify type of floor		
	Specify roughness of floor		
	Acoustic level approved by local authorities (if required)		
Remote control system	Access to a telephone line or access to a GSM subscription in case a GSM modem (option) is to be used.		

2.2T100s3_IM4_rev02.fm

4.1.2 Comments to the Installation preparations check list

4.1.2.1 Placement of the T100

Turbec recommends to:

- mark with paint the limits of the indoor service area on the floor.
- fence in outdoor installations to avoid damage and unauthorized operation.
- avoid placement in areas that tend to be flooded or be covered in deep snow.
- if winds over 35 m/s [78 m.p.h.] can be expected, place the T100 indoors or fasten the machine to the ground.
- bolt or with other means fasten the machine to the ground in earthquake zones. Please consult local authorities or local authorized technical personnel to assess earthquake risk requirements.

Make sure it is possible to access the installation site for the T100. The T100 is very compact and will pass through normal door openings, but due to the length it might be difficult to pass corners in buildings, or when a door is placed on one side of a corridor.
Note the most narrow area to pass through with the T100 in the check list on the previous page.

All requirements for the service area must be met. Dimensions required for this purpose are found in chapter *3 Drawings and Technical data***.**
Note the actual service area reserved for the T100 equipment in the check list on the previous page.

Make sure there is access to lifting device meeting the requirements stated in chapter *5 Crate handling*.
Note the type of lifting device available for the installation in the check list on the previous page.

Consider the length of air supply ducts, ventilation pipes and exhaust gas pipes when placing the T100. The ducts must have sufficient dimensions since the pressure drop will have an impact on the performance level of the T100.

(Continued)

2.2T100s3_IM4_rev02.fm

(Continued)

4.1.2.2 Fuel system

The fuel demand corresponds to a supply of heat of at least 333 kW based on the Lower Heating Value (LHV), with a pressure in the range of 0.02 bar (g) to 1.0 bar (g).
Note the LHV for the fuel, and the pressure level in the check list on the previous page. Also note if there is any fuel quality fluctuations.

Example:
For fuel gas with LHV =39 MJ/m_n^3, the volume flow required for continuous production of 100 kW is 31 m_n^3/h and maximum 40 m_n^3/h under acceleration.

For a natural gas installation, the Wobbe index shall be in the range 43-55MJ/m^3.

Note! Make calculations on maximum pressure drop on site gas pipe installation, to avoid under-sized gas delivery.

If the gas grid delivers high pressure gas; 6.0 - 8.0 bar (g), the fuel booster can be removed from the T100. If the gas pressure is higher than 8.0 bar (g) a reducing valve must be installed.

Note! Other fuels than standardized natural gas has to be analysed and approved by Turbec before installation.

4.1.2.3 Electrical installation

Make sure there are sufficient capacity for the connection points, and that the grid connection is dimensioned to handle the power output from the T100.

Furthermore, make sure all local requirements are fulfilled, even the ones that are site specific.

External cables, disconnecting switches and fuses must be ordered before installation. See *section 7. Electrical installation* for further information about the cables, switches and fuses. Note that long cables will add installation cost (but with negligible transmission losses).

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4.1.2.4 Air supply

Indoor installation:

Note! The inlet air must be taken from a non-hazardous area (EN 60079-10). For definition of hazardous area, see *section 2.5.1.1 Definitions (according to IEC/EN 6079-10):*.

The coarse pre-filter is an option for an indoor installation. Since air ducts, between the T100 and the coarse pre-filter, are not included in the Turbec scope of supply, they must be ordered.

Turbec recommends to mount the coarse pre-filter on an outside wall, preferable on a wall facing north (better performance due to low temperatures). The coarse pre-filter must be mounted so that rain or snow can not enter the system.

All air ducts must be suspended properly in order to not add any extra forces and weight to the connection flanges.

Outdoor installation:

For an outdoor installation, the pre-filter is integrated in the outdoor roof module.

4.1.2.5 Ventilation

Indoor installation:

Since air ducts between the T100 and the evacuation fan are not included in the scope of supply, they must be ordered. Turbec recommends to insulate the leaving air duct.

The evacuation fan is designed for outdoor use. Turbec recommends to mount the fan as close as possible to the ventilation outlet.

All air ducts must be suspended properly in order not to add any extra forces and weight to the connection flanges.

Outdoor installation:

For an outdoor installation, the evacuating fan is mounted directly to the ventilation outlet on the T100.

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4.1.2.6 Exhaust gases

Indoor installation:

The length of the exhaust pipe is important since the thermal expansion requires an expansion bellow if there are no possibilities to route the exhaust gases directly out through the wall. If the exhaust pipe before the wall is longer than 2-3 meters, an expansion bellow has to be ordered. An extra pressure drop of 2 KPa means 5% less power output.

All air ducts must be suspended properly in order not to add any extra forces to the connection flanges.

Turbec recommends to insulate the exhaust pipe.

Note! The following instruction is only valid for indoor installations that intend to fulfil the standard, *Stationary Engine Generator Assemblies UL 2200:*
Exhaust piping and chimneys shall be designed, constructed, and installed in accordance with the Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines, NFPA 37.

Outdoor installation:

For an outdoor installation, a chimney stack is included in the scope of supply. It is mounted directly to the T100. No further equipment is needed.

4.1.2.7 Hot water (T100 PH)

If other heat sources are connected to the same heating system, it is beneficial with a close distance due to pressure drop, thermal losses in the distribution system and installation costs.

4.1.2.8 Turbine room

The floor shall preferable have a smooth, but hard, surface. It is recommended to use a oil resistant layer of epoxy, or equal, as the floor might be exposed to smaller amounts of oil spillage.

Some mobile lifting devices need a minimum clearance of 100 mm between the floor and the machine. If the floor is not completely levelled, or rough in its structure, a higher clearance is necessary. The clearance must be in the range of 100 to 135 mm. See *section 6. Mechanical installation and connection* for further information.

The noise level might have to be reduced if the T100 is located close to a residential area. In doubtful cases, check with the local authorities.

4.1.2.9 Remote control system

The preferred solution is to use an existing telephone line for connection via the remote system. It is also possible to arrange for network connection, or for GSM connection.

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5. Crate handling

2.2T100s3_IM5_rev02.fm

5.1 Crate data

The T100 microturbine is shipped in up to five crates.

The table below shows the number of crates delivered for the different variants of the T100.

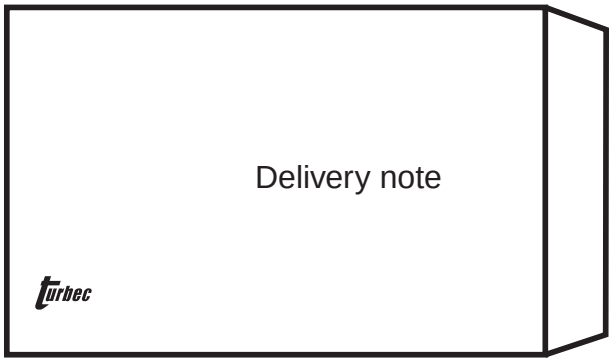
	Indoor installation	Outdoor installation
P	3	4
PH	5	5

5.1.1 Contents

Crate	Contents
A	T100 Power Module Ventilation air outlet duct
B	Combustion and ventilation air inlet filter (optional)
C	Evacuation fan
D	Heat exchanger
E	Exhaust gas pipe kit
F	Heat exchanger enclosure
G	Outdoor air intake module, including air inlet filter Outdoor outlet module Chimney

Note! One copy of the packing list is located on the side of crate A.

See the package list for more details.



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5.1.2 Weight and dimensions

Crate	Gross weight (kg)	Net weight (kg)	Length (mm)	Width (mm)	Height (mm)
A	2300	2150	3200	1200	2150
B	120	50	1 400	1 100	1 050
C	89	59	820	620	1 060
D	450	450	930	826	1 450
E					
F	75	55	316	210	300
G	458	408	2090	1250	250

5.2 Crate delivery

The number of crates delivered depend on the machine variant. Crate A contains a machine specification where details about the delivery can be found, such as number of crates and contents of the crates.

Note! It is not necessary that the delivered crates have consecutive alphabetic denominations.

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5.2.1 Indoor installation

The table below shows which crates are delivered for the different indoor installations.

Crate	P	PH
A	1/3	1/5
B	2/3	2/5
C	3/3	3/5
D	-	4/5
E		
F	-	5/5
G	-	-

5.2.2 Outdoor installation

The table below shows which crates are delivered for two different outdoor installations.

Crate	P	PH
A	1/5	1/5
B	-	-
C	2/5	2/5
D	-	3/5
E	3/5	
F	4/5	4/5
G	5/5	5/5

5.3 Lifting equipment

5.3.0.1 Different types of lifting equipment

The following types of equipment can be used to lift and move the crate A:

- overhead gantry
- mobile crane
- fork lift

The most practical equipment is an overhead gantry.

Note! The other crates are best moved using a fork lift.

5.3.0.2 Equipment specifications

- Make sure that the lifting capacities of the equipment and tackle comply with the minimum values given in the following table:

Equipment or tackle	Lift capacity (kg)	Notes
Overhead gantry	3000	4000 kg required if gantry does not have gradual acceleration/deceleration ramps.
Mobile crane	3000	4000 kg required if gantry does not have gradual acceleration/deceleration ramps.
Lifting chains, cables, ropes or slings	3000	4000 kg required if gantry does not have gradual acceleration/deceleration ramps.
fork lift	4000	The higher capacity may be required to reach the centre of gravity

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5.4 Unpacking area

The required unpacking area for the different machine variants should ideally have the approximate dimensions given in the following table.

	Indoor installation (mm) Area required L x W x H	Outdoor installation (mm) Area required L x W x H
P	4800 x 5000 x 3300	4800 x 6850 x 3300
PH	7660 x 5000 x 3300	7660 x 6850 x 3300

Note! These dimensions allow about 1 000 mm of free space around and above the crates and contents, with the contents removed and placed on the floor outside the crates.

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5.5 Unloading the crates

Make sure everybody understands the symbols and warnings used on the crates.

Symbol	Meaning
	Centre of gravity
	Lifting points for chains, cables ropes or slings.
	This way up
	Fragile
	Keep dry
TOP	Top of crate
FRAGILE	“Fragile” warning
HANDLE WITH CARE	“Handle with care” warning
NOT TO BE DROPPED	“Not to be dropped” warning
GROSS KG.	“Gross weight” value
NET KG.	“Net weight” value

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5.5.1 Inspection of crates

Please inspect the outside of the crates before starting to unload. Record any damages on the Transport damage report (see *section 12. Appendix: Start-up machine quality report*).

5.5.2 Using an overhead gantry or mobile crane

Hanging load

Keep clear of suspended loads. See *section 2. Safety precautions*. Check the gross weight of crate and make sure that the lifting equipment is suitable.

If using a fork lift, see *section 5.5.3 Using a fork lift*.

The following instructions apply to crate A.

a) Make sure that the tackle has the correct length and lifting capacity for the crate being lifted. See *section 5.3 Lifting equipment*.

The length shown in the figure below is the hook-to-hook length. If the lifting tackle has to be joined to make up the necessary lengths, make sure that the joints are secure and have the same lifting capacity as the rest of tackle.

b) Manoeuvre the hook to one side of the crate.

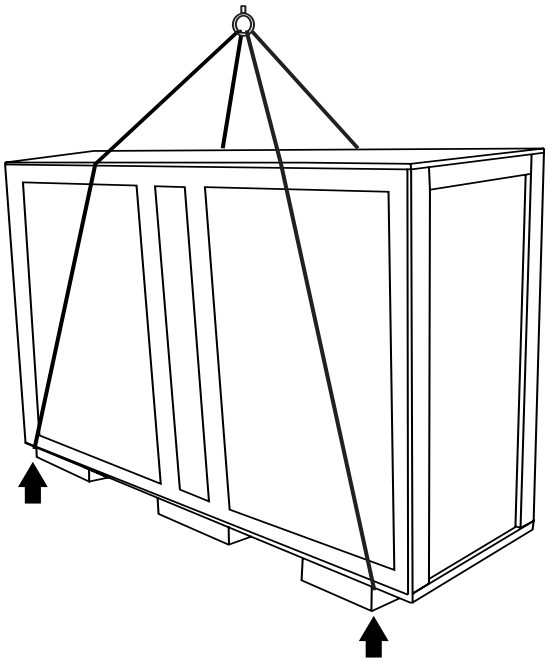
c) Pass the lifting tackle under the crate at the points shown in the figure below.

d) Secure the tackle to the lifting hook and fit the safety clip on the hook.

e) Manoeuvre the hook over the centre of the crate.

f) Slowly take up the slack in the lifting tackle. Make sure that the tackle is secure at the crate and hook. If necessary, adjust the tackle to distribute the load evenly.

Tackle length min 7000 mm



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2.2T100s3_IM5_rev02.fm

(Continued)

g) Prepare ropes or poles to steady and manoeuvre the load. Do not use hands or feet.

h) Lift the crate enough to clear the platform of the vehicle.

i) Remove the vehicle from under the crate.

j) Lower the crate gently to the floor.

k) Make sure that the crate is firmly supported. Place blocks or plates under if necessary.

l) Lower the lifting hook and remove the lifting tackle.

Note! Do not unpack the crates until you are ready to start installing

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5.5.3 Using a fork lift

DANGER!

Risk of crushing!
Keep clear of suspended loads. See *section 2. Safety precautions*. Check the gross weight of crate and make sure that the lifting equipment is suitable.

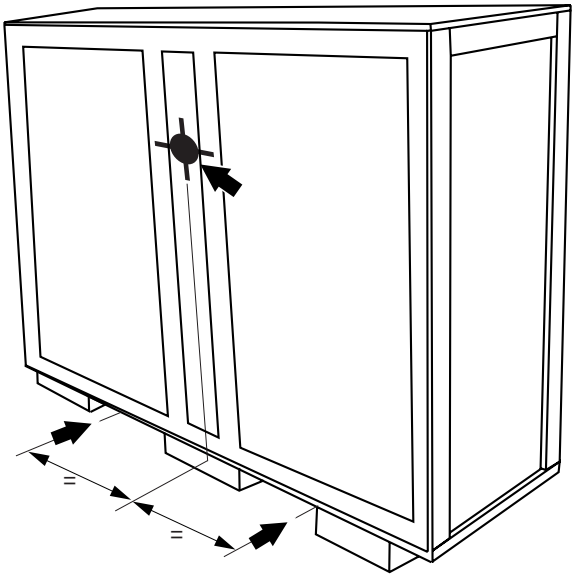
If using an overhead gantry or mobile crane, see *section 5.5.2 Using an overhead gantry or mobile crane*.

The following instructions apply to all crates.

a) Make sure that the forks used are of the correct length and lifting capacity for the crate being lifted. See *section 5.3 Lifting equipment*.

b) Set the lifting forks to the correct width. See *section 5.3 Lifting equipment*.

c) Manoeuvre the fork lift so that the forks engage the crate no further apart than the points shown in the figure below, and at equal distance from the centre of gravity symbol. If the crate is fitted with fork tubes, manoeuvre the forks inside these to lift the crate.



d) Lift the crate enough to clear the platform of the vehicle.

e) Remove the vehicle from under the crate.

f) Lower the crate gently to the floor.

g) Make sure that the crate is firmly supported. Place blocks or plates under it, if necessary.

h) Remove the forks from under the crate.

5.6 Moving and Storage

5.6.0.1 Important notes

If the crates have to be stored before installation, make sure that the storage area complies with specifications before storing the crates there. See *section 5.6.2 Storage,* below.

If installation starts immediately, check whether it is possible to move the crates to the installation site. Unpacking and installation can be performed together.

When moving the crates to the installation site, deposit them so that the T100 microturbine can be lifted out and positioned without being turned around.

Wait until installation can start before unpacking the crates.

5.6.1 Moving

The following instructions apply to all crates.

a) Lift the crate as instructed above only enough to clear the floor, see *section 5.5 Unloading the crates*.

b) Make sure that the crates remain stable on the lifting equipment.

Caution! Move the crate slowly and gently.

c) Move the crate to the assembly destination.

d) Lower the crate gently to the floor. Leave enough room for access to all sides.

e) Make sure that the crate is firmly supported. Place blocks or plates under the crate if necessary.

f) Remove the lifting equipment

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5.6.2 Storage

Caution! Store the crates indoors. Exposure to moisture or too high or low temperature may damage the T100 microturbine and its equipment.

a) Make sure that the storage area has the approximate dimensions to store all the crates with at least 1 000 mm of free space around and above each one for access and ventilation.

b) Make sure that the indoor storage environment respects the conditions given in the table below.

Characteristic	Value	Notes
Min - max temperatures	5-40 °C (41-104 °F)	
Max relative humidity	80%	Non-condensing

c) Manoeuvre the crates into position one by one, leaving at least 1 000 mm of free access space around each one.

d) If the floor under the crate is uneven, place blocks or plates under the crate to provide steady support.

e) Make sure that the crate is stable and remove the lifting equipment.

Caution! It is possible to stack crate C and E on top of crate A or crate E on top of crate B. Do not stack any crate on crate D, F and G.

5.7 Opening the crates

DANGER!

Hanging load
Keep clear of hanging loads, see the *section 2. Safety precautions*.

The following instructions apply to crate A.

a) Use a 10 mm wrench to remove the top of the crate and the reinforcement cross beams.

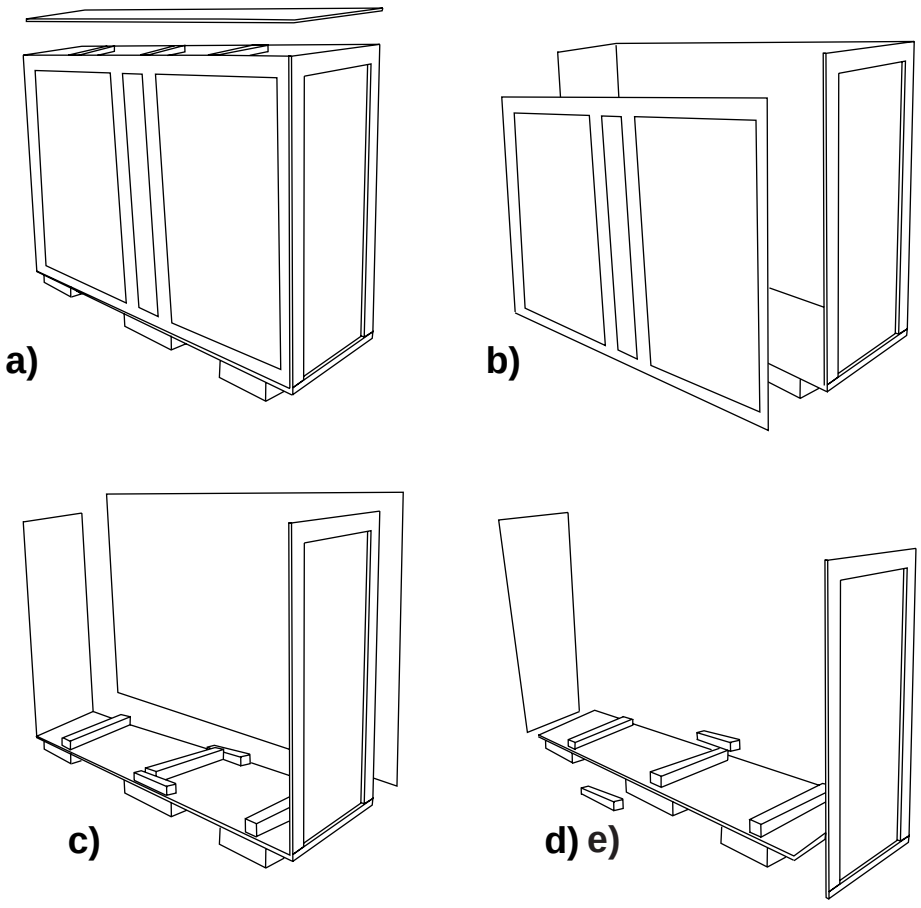
Caution! Check for screws and wire which could hold equipment to the crate.

b) Loosen any screws fixing the contents to the front of the crate and remove the front of the crate.

c) Loosen any screws fixing the contents to the back of the crate and remove the back of the crate.

d) Loosen any screws fixing the contents to the sides of the crate and remove the sides of the crate.

e) Remove the screws and blocks fixing the T100 microturbine to the floor of the crate.



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5.8 Unpacking the crates

5.8.1 Unpacking crate A (Microturbine)

Crate A contains the T100 microturbine, accessories and machine documents. If the machine delivered is an indoor T100 PH, the crate also contains a ventilation outlet duct.

Caution! Failure to perform the following instructions in the order in which they are given may result in damage to the crate or to the T100 microturbine.

a) Remove all loose boxes and packages.

5.8.1.1 Using an overhead gantry or mobile crane

If using a fork lift, see *section 5.8.3.2 Using a fork lift*

Caution! Use a lifting yoke when lifting the T100 microturbine with an overhead gantry or mobile crane. The 100 microturbine is not designed to be lifted without a lifting yoke and the upper sub frame will be damaged by torsional forces.

Hanging load

Keep clear of hanging loads. See *section 2. Safety precautions*. The T100 microturbine weighs approximately 2 200 kg. Make sure that the lifting equipment is suitable.

a) Remove the front and back doors and covers of the T100 microturbine to avoid squeezing them with the lifting belt.

b) Fit the lifting tackle to the overhead gantry or mobile crane with the lifting yoke. Use a correct length of the tackle.

c) Fit the lifting belt around the T100 microturbine.

d) Make sure the lifting capacities of the lifting equipment, and the tackle used to lift the T100 microturbine, comply with the following minimum value: **3 000 kg**.

Note! A lifting capacity of 4 000 kg is required if gantry does not have gradual acceleration/deceleration ramps.

(Continued)

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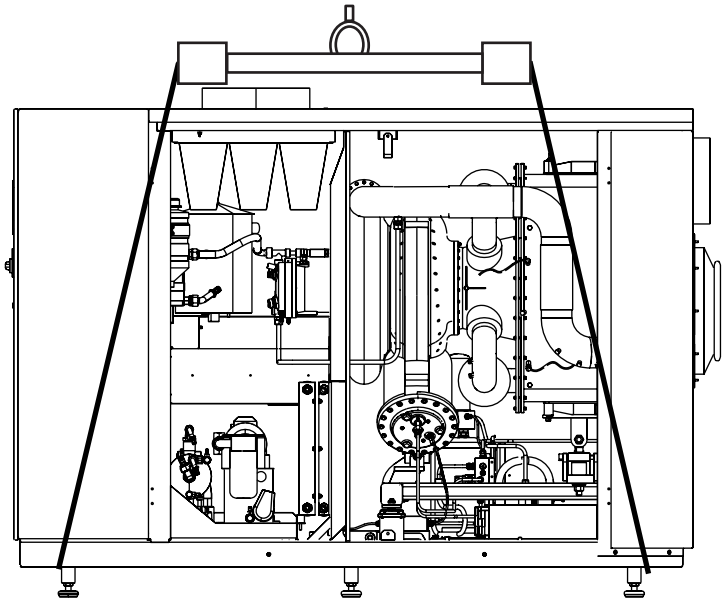
e) Connect the lifting belt to the lifting tackle. Make sure that equipment is not worn or damaged.

f) Slowly take up the slack in the lifting tackle. Make sure that the tackle is secure at the lifting belt and hook. If necessary, adjust the tackle to distribute load evenly.



g) Lift the T100 microturbine only enough to clear the legs from the crate.

h) Manoeuvre the T100 microturbine out of the crate.

i) Lower the T100 microturbine gently to the floor to its position.

j) Make sure that the T100 microturbine is placed horizontal and stable and remove the lifting equipment.

k) Mount the doors and covers to their positions.

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5.8.1.2 Using a fork lift

If using an overhead gantry or mobile crane, see *section 5.8.1.1 Using an overhead gantry or mobile crane*.

DANGER!

Risk of crushing!

Keep clear of suspended loads. See *section 2. Safety precautions*. The T100 microturbine weighs approximately 2 200 kg. Make sure that the lift equipment is suitable.

(Continued)

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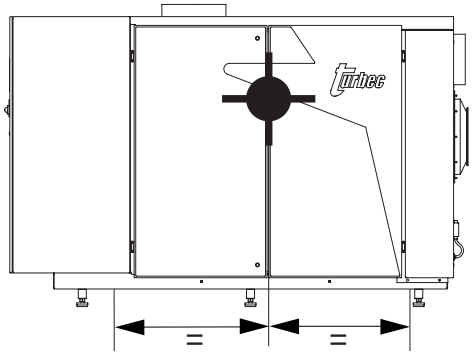
a) Make sure the lifting capacities of the fork lift used to lift the T100 microturbine comply with the following minimum value: **3 000 kg.**

b) Set the lifting forks to the correct width.

c) Manoeuvre the fork lift so that the forks engage the T100 microturbine no further apart than the points shown in the figure below, and at equal distance from the centre of gravity.

Note.
The picture show the service side of the T100 microturbine



Caution! Make sure that the forks support the frame members on both sides of the machine body before starting to lift

d) Lift the T100 microturbine to clear the legs of the crate platform.

e) Manoeuvre the T100 microturbine out of the crate platform.

Caution! If the T100 microturbine is not supported evenly, the frame may be subjected to damaging torsional forces.

f) Lower the T100 microturbine gently to its position on the floor.

g) Make sure that the T100 microturbine is horizontal and stable before removing the forks.

5.8.2 Unpacking crate B, C, E and F

a) Remove all loose items inside the crate.

b) Remove the screws and blocks fixing the equipment to the floor of the crate.

5.8.3 Unpacking crate D (Heat exchanger)

Caution! Failure to perform the following instructions in the order which they are given may result in damage to the heat exchanger.

5.8.3.1 Using an overhead gantry

If using a fork lift, see *section 5.8.1.2 Using a fork lift*.

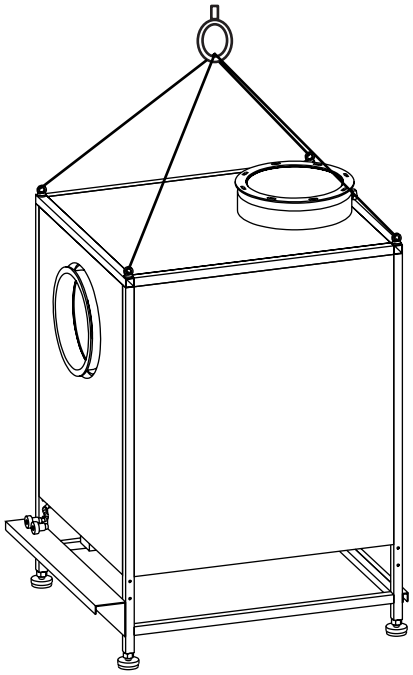
DANGER!

Hanging load

Keep clear of hanging loads. See *section 2. Safety precautions*. The heat exchanger weighs approximately 450 kg. Make sure that the lifting equipment is suitable.

Caution! When lifting the unit with chains always use the lifting lugs. Maximum lifting angle between the chains is 45°.

a) Connect the lifting equipment to the lifting lugs on the heat exchanger.



b) Lift the heat exchanger enough to clear the legs from the floor.

c) Manoeuvre the heat exchanger to its position.

d) Lower the heat exchanger gently to the floor to its position.

e) Make sure the heat exchanger is placed horizontal and stable, and remove the lifting equipment.

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5.8.3.2 Using a fork lift

If using an overhead gantry, see *section 5.8.3.1 Using an overhead gantry*.

DANGER!

Risk of crushing!
Keep clear of suspended loads. See *section 2. Safety precautions*. The heat exchanger weighs approximately 450 kg. Make sure that the lift equipment is suitable.

Caution! When a fork lift is used for lifting the heat exchanger, lift with the lower beams on the unit. Observe that the centre of gravity on the unit is very high measured from the floor, so when lifting with fork lift secure the unit from tilting.

a) Manoeuvre the fork lift so that the forks engage the heat exchanger at equal distance from the sides.

b) Lift the heat exchanger enough to clear the legs from the floor.

c) Manoeuvre the heat exchanger into its storage position.

d) Make sure that the heat exchanger is horizontal and stable before removing the forks.

5.8.4 Unpacking crate G (Outdoor module)

Caution! Failure to perform the following instructions in the order which they are given may result in damage to the outdoor module

DANGER!

Risk of crushing!
Keep clear of suspended loads. See *section 2. Safety precautions*. The outdoor module weighs approximately 360 kg. Make sure that the lift equipment is suitable.

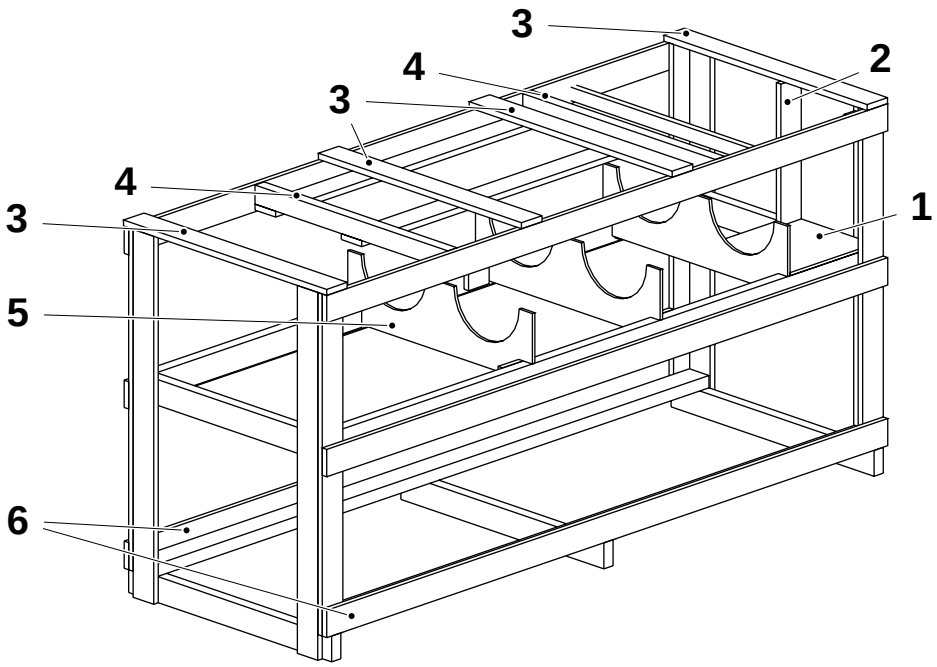
a) Remove upper boards (4) and vertical support (2).

b) Unpack tray (3) and lift it off.

c) Lift out chimneys and box from shelf (1) before removing side sections (6) and mid section (5).

d) Remove the outdoor inlet module.

1.Box shelf
2.Vertical support
3.Tray
4.Upper boards
5.Mid section
6.Side section



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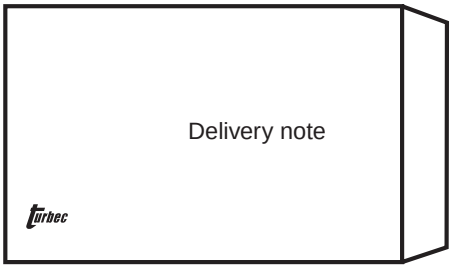
5.9 Inspection

a) Use the delivery note to check that nothing is missing from the crates.



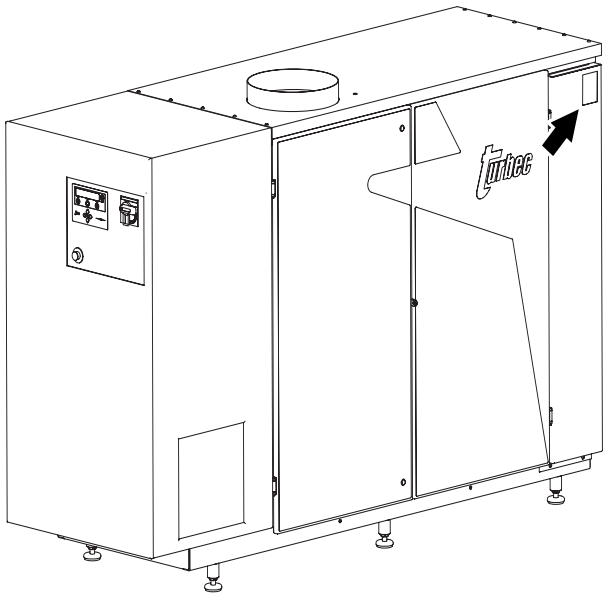
Note! One copy of the delivery note is located on the side of crate A.

b) Inspect the T100 microturbine for damage.

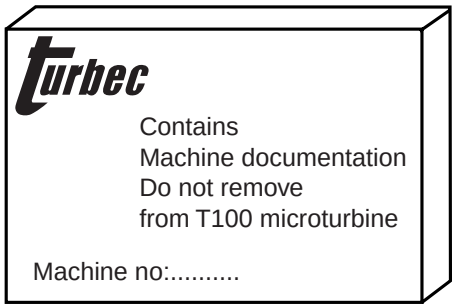
c) Inspect the T100 microturbine's external parts for damage.

d) Open the boxes containing the smaller components and inspect these for damage.

e) Check that the data on the equipment sign corresponds with the data in the machine specification document.



f) Open the Machine document box and remove the documentation.



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g) Locate the following documents:

- Machine specification document
- Acceptance test report
- Machine deviation report (if relevant)
- Start-up machine quality report (including the Transport damage report)
- Customer satisfaction form
- System drawings

h) Take the spare parts to the spare parts store.

i) If needed fill in the Transport damage report (a section of the Start-up machine quality report).

5.9.0.1 Compiling the documentation

a) Procure the Transport damage report form from the local service organisation.

b) Fill in the Transport damage report form and deliver it to the local service organisation. They will send it to the manufacturer.

5.10 Disposal/return of packing

Note! Packaging (including the crates, wrapping and boxes) is normally not returned to the manufacturer.

a) Please check if there is a special agreement for the return of the packing to the manufacturer.

b) If packing must be returned to the manufacturer, prepare an area the size of crate A in which to store the crate and any other returnable packing.

c) Check with the customer if there is a special arrangement for recycling packing.

d) If packing is not to be returned or recycled, check with the customer how to separate and dispose of packing (wood, plastic paper, etc.).

e) Dispose of pollutant waste (bubble wrapping, plastic bags, expanded polystyrene, etc.) in accordance with local regulations.

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6. Mechanical installation and connection

2.2T100s3_IM6_rev02.fm

6.1 General requirements

6.1.0.1 Personnel

Only qualified installation personnel are authorized to assemble the T100 microturbine. See *section 2. Safety precautions* for a definition of installation section Personnel.

6.1.0.2 The installation area

a) Clear the installation site. If necessary clean the floor before installing the T100 microturbine.

b) Make sure that there is sufficient room to move safely around the installation, see *section 3.1 Installation drawings*. If any potential machines around the site cannot be stopped, take measures to prevent accidental contact.

c) Make sure that lighting is adequate and arrange additional portable lights if necessary.

d) Make sure that a documented area classification is present.

6.1.0.3 Lifting equipment, tools and materials

The equipment used for lifting and moving the crates can also be used for unpacking the crates and installing the T100 microturbine, see *section 5.3 Lifting equipment*.

6.1.0.4 Packing

Leave the bubble wrapping on the parts until they are ready for use.

Leave the plastic plugs in the pipes until they are ready to be connected, but do **not** forget to remove them before connecting the pipes.

Leave ties in place until tied parts are ready to be used or connected.

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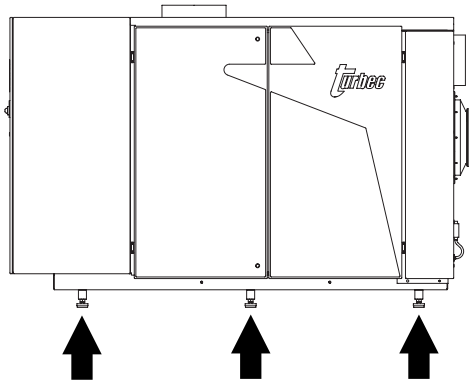
6.2 Positioning

a) Lift the T100 microturbine as instructed, see *section 5.8.1 Unpacking crate A (Microturbine)*.

b) Slowly manoeuvre the machine to the installation position.

c) Lower the machine gently into position. Do not remove the lifting equipment yet.

d) Position the six feet under the six legs as shown in the figure below.

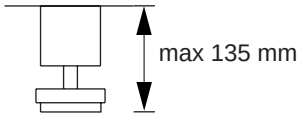


e) Check that the T100 microturbine is correctly positioned with respect to the site. See *section 3.1 Installation drawings*.

DANGER!

Risk of crushing!

Do not unscrew the legs more than 135 mm. They can come out completely.



Note! Use a minimum length of 100 mm of the legs to allow maintenance work. If the floor is not in level, use a higher height to compensate.

f) Position the six legs to distribute weight of the T100 microturbine evenly. Make sure the T100 microturbine is levelled horizontally.

g) Make sure that the T100 microturbine is supported and stable on all six legs and feet and remove the lifting equipment.

h) Level the T100 microturbine transversely and longitudinally ± 1mm/m.

6.3 Release transport locking device

The T100 microturbine is equipped with red transport locking devices. Release these before the T100 microturbine is ready for operation.

a) Open right front door and right back door.

b) Locate the red quadrangular bar on the top on the recuperator (3).

c) Loose screw (2) 1 mm.

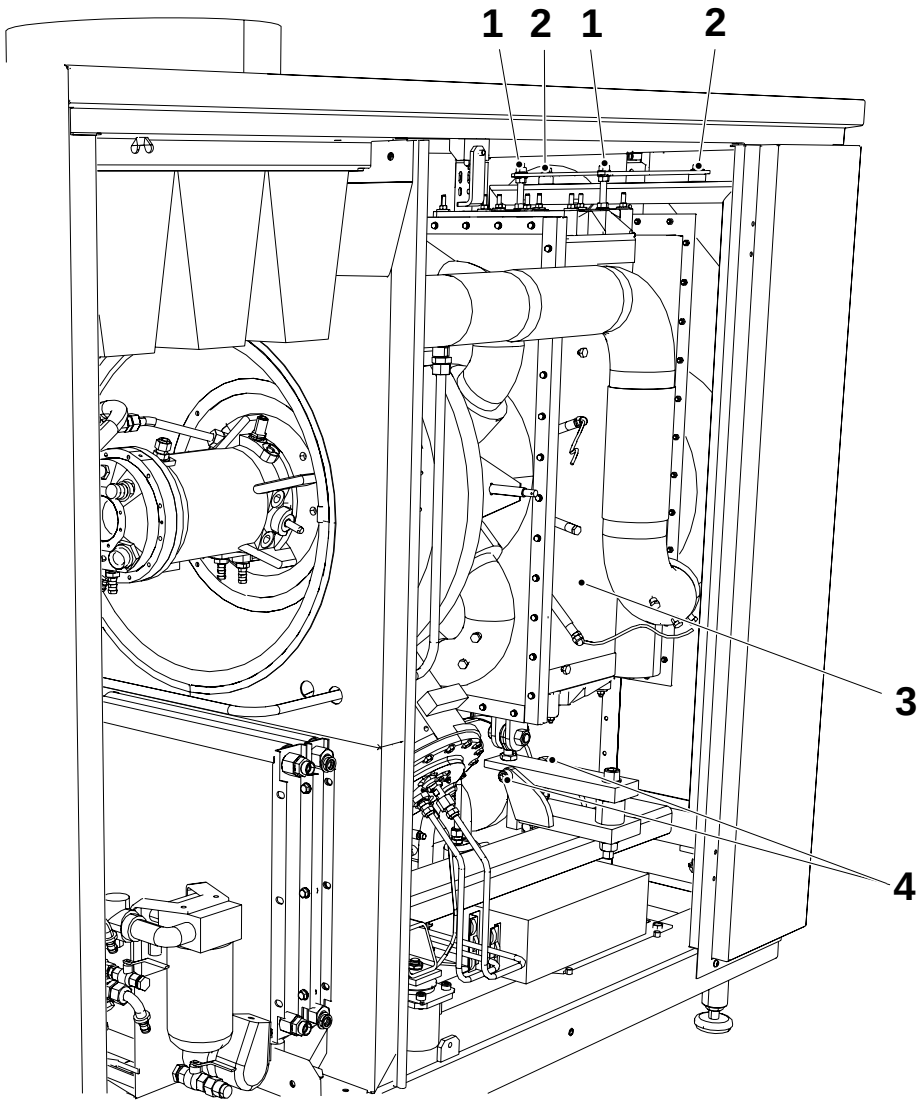
d) Loose upper nut (1) 1 mm on the upper side of the bar.

e) Drop lower nut 3 mm on the under side of the bar.

f) Locate the red nuts (4) on link below the recuperator (3).

g) Loose nuts (4) 10 mm.

1. Nut
2. Screw
3. Recuperator
4. Nut



Front view

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6.4 Installation instructions

6.4.1 Indoor installation

The table below shows which installation instructions to be used for the different variants of the machine.

	T100 P	T100 PH
6.5.1	x	x
6.5.2		x
6.5.3.1	x	
6.5.3.2		x
6.5.4.1	x	
6.5.4.2		x
6.5.5		x
6.5.6		x
6.5.7	x	x

6.4.2 Outdoor installation

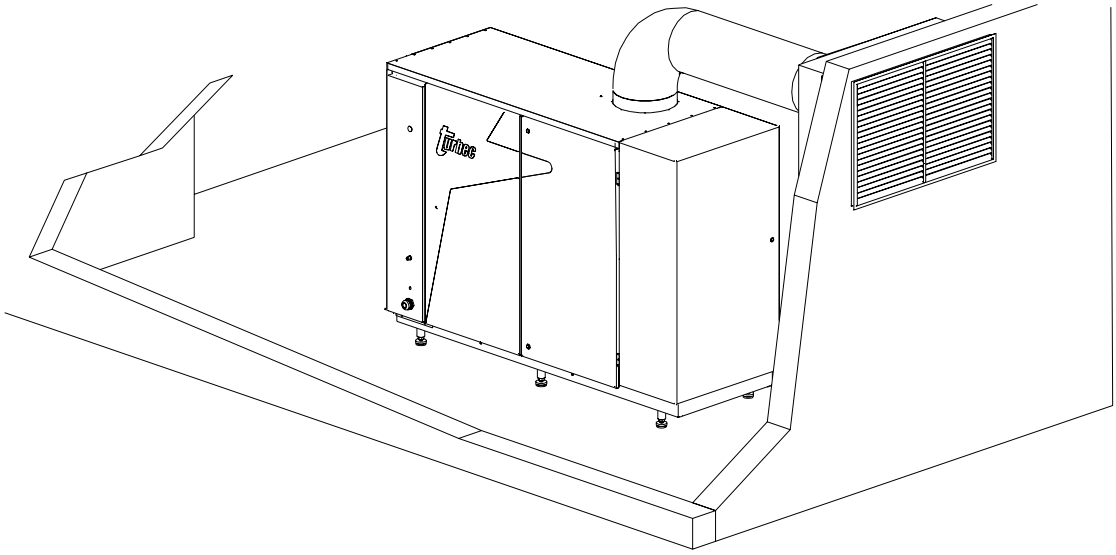
The table below shows which installation instructions to be used for the different variants of the machine.

	T100 P	T100 PH
6.5.2		
6.5.6		x
6.5.7		
6.5.8	x	x
6.6.1	x	x
6.6.2		x
6.6.3		x
6.6.4	x	x
6.6.5.1		x
6.6.5.2	x	
6.6.5.3	x	
6.6.6.	x	x
6.6.7		x
6.6.8	x	x

6.5 Indoor installation

6.5.1 Combustion and ventilation air induct installation

Dimension of connection:	Ø 400 mm (15.75“), male connection
Connection type:	Twisted galvanized tube
Approximate air flow:	1.69 kg/s (=1.38 m^3/s) (3.73 lb/s =48.7 ft^3/s)



a) Install a coarse filter mounted in an ambient air intake, size about 1150 x 750 mm (45.25 x 29.50”).

The coarse filter is available as an option from Turbec. It can also be supplied from a local supplier if the following requirements are observed:

Pre-filter type:	G3, (EU3)
Min air flow at 15°C (59°F):	1.69 kg/s (=1.38 m^3/s) (3.73 lb/s =48.7 ft^3/s)
Max pressure drop for a clean filter:	< 50 Pa (0.20” W.C.)
Max pressure drop for a worn filter:	< 190 Pa (0.76” W.C.)

Note! Make sure the preferred filter type uses an intake screen, for example use two standard size cases with the dimensions: 497 x 597 x 54 mm (19.57 x 23.50 x 2.13”).

b) Install a duct, Ø 400 mm (Ø 15.75”) female connection, from the ambient air intake to the interface of T100 microturbine.

Caution! The flange on the T100 is not designed to carry forces from the ventilation system. Extra weight, may seriously damage the machine.

Note! The air inlet duct must be designed for a maximum pressure drop of less than 80 Pa (0.32” W.C.), for example 10 m DN400 (15.75”) and two bends, DN400.

c) Fit the duct with min 30 mm (1.18”) of condense insulation.

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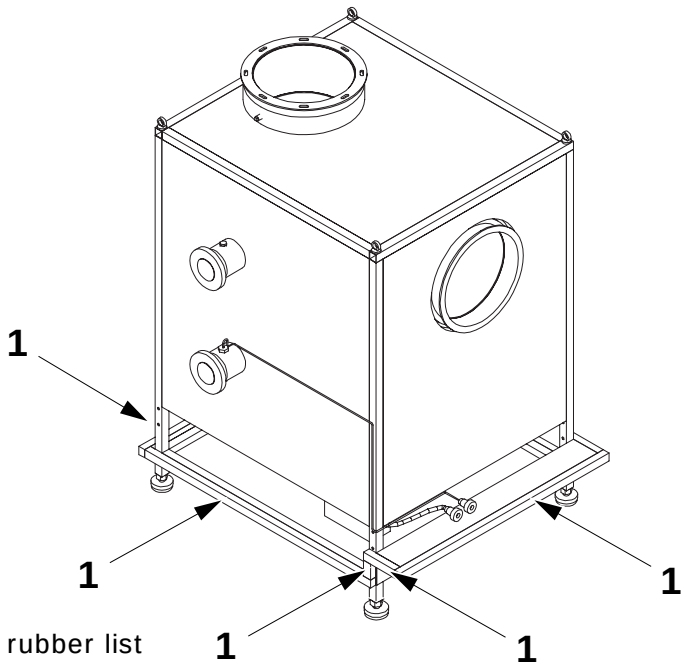
6.5.2 Heat exchanger installation - T100 PH

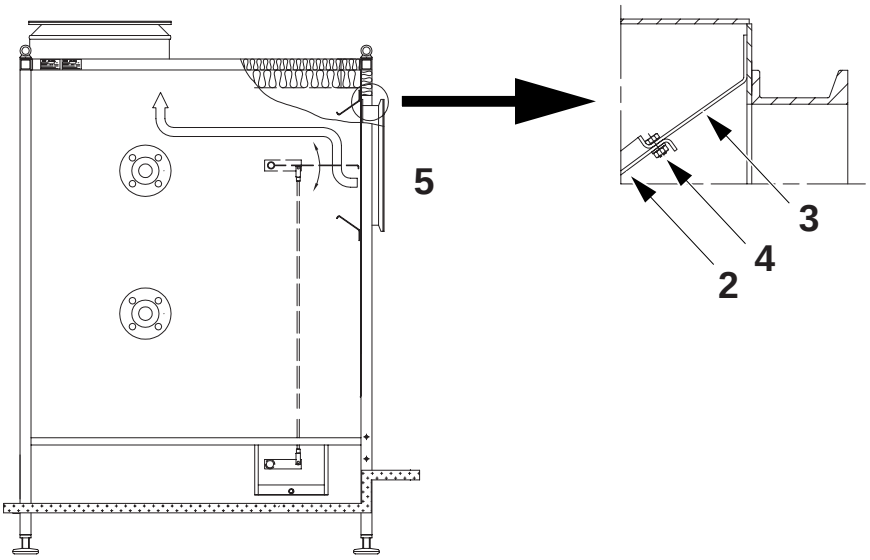
a) Fit the self-adhesive rubber list (1) to the lower edge of the heat exchanger.



1 Self-adhesive rubber list

If the heat exchanger is not equipped with by-pass function, please continue to d).

b) The by-pass damper (2) is fastened to a sealing plate (3) with 1xM5 nut (4). It is reached through the heat exchanger exhaust gas inlet (5).



2 By-pass damper
3 Sealing plate
4 Nut
5 Exhaust gas inlet

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(Continued)

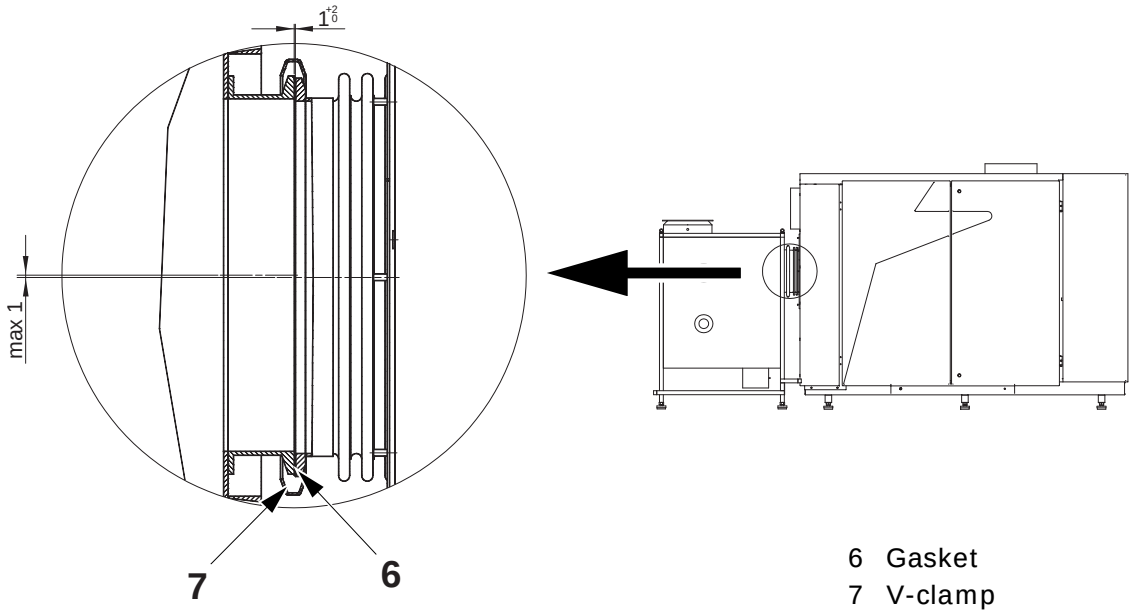
c) Remove the nut (4) with an open end wrench, size 8 mm.

d) Remove the gasket (6) and V-clamp (7) from the recuperator bellow.

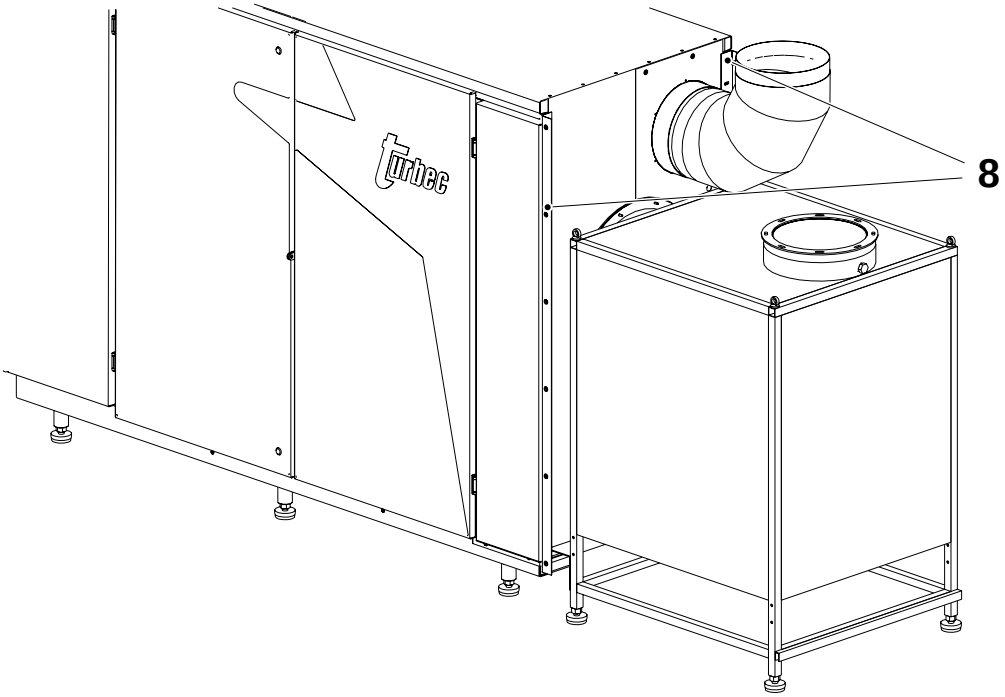
e) Use super glue or tape to fit the gasket to the heat exchanger exhaust gas inlet.

f) Lift the heat exchanger as instructed, see *section 5.8.3 Unpacking crate D (Heat exchanger)*

g) Fit mounting angles (8) to the T100. Use a 13 mm spanner.



6 Gasket
7 V-clamp
8 Mounting angles



2.2T100s3_IM6_rev02.fm

Caution! When lifting the unit with chains always use the lifting lugs. Maximum lifting angle between the chains is 45°.

Caution! When a fork lift is used for lifting the heat exchanger, lift with the lower beams on the unit. Observe that the centre of gravity on the unit is very high measured from the floor, so when lifting with fork lift secure the unit from tilting.

h) Remove insulation around flange.

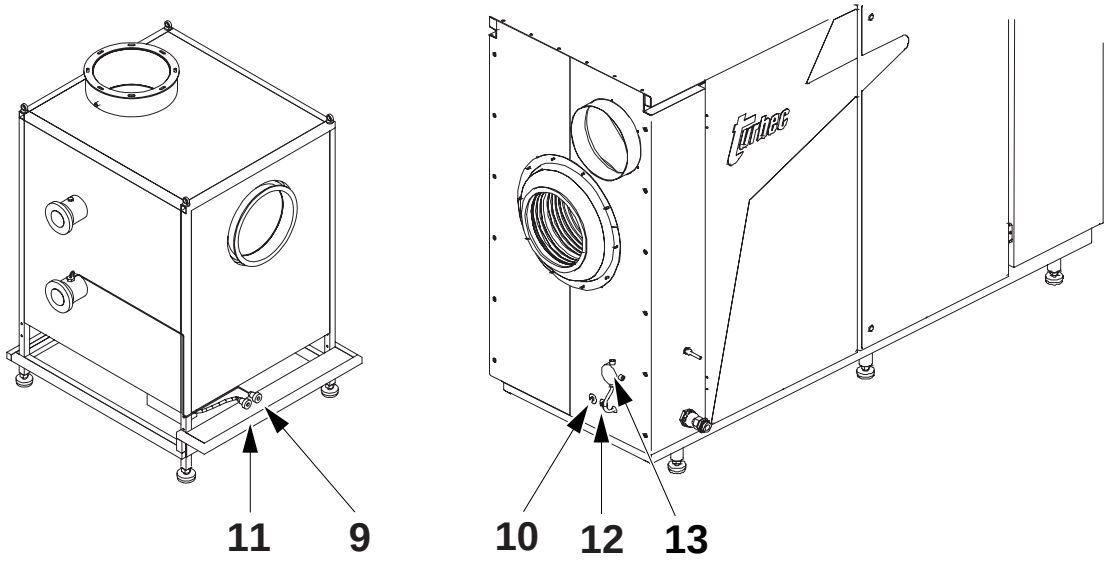
i) Slowly manoeuvre the heat exchanger into correct installation position.

Note! Correct position for the installation: Flange centre offset max 1 mm in any direction. The axial distance may be 0 - 3 mm.

Caution! Make sure there is no compression of the bellow during installation.

j) Connect the heat exchanger output temperature sensor cable (9) to the inner contact (10) on the side of the T100.

k) Connect the heat exchanger by-pass motor cable (11) to the outer contact (12) on the side of the T100.



9 Heat exchanger output temperature sensor cable
10 Heat exchanger output temperature sensor connector
11 Heat exchanger by-pass motor cable
12 Heat exchanger by-pass motor connector
13 Evacuation fan electrical power connector

Caution! The T100 can not be moved after the heat exchanger installation. If it is necessary to move the machine, the heat exchanger must be disconnected from the power unit.

l) Lower the heat exchanger gently into position. Do not remove the lifting equipment yet.

m) Adjust the height by means of the legs.

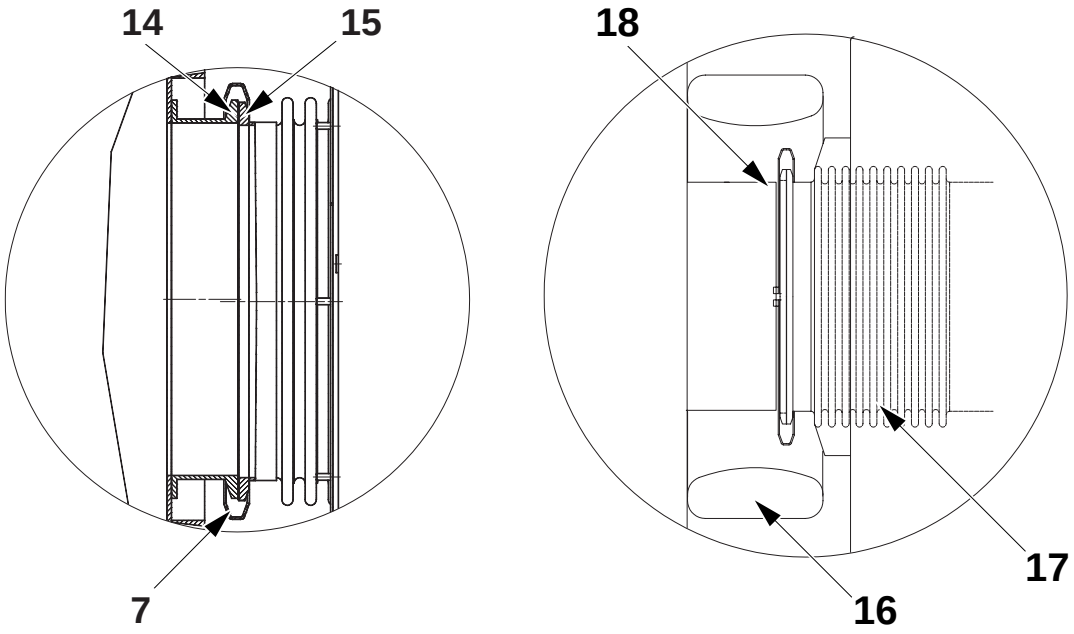
n) Distribute the weight of the heat exchanger evenly on the legs. Make sure the heat exchanger is levelled horizontally.

o) Make sure the heat exchanger is stable on all legs and feet before removing the lifting equipment.

p) Fasten the V-clamp around the recuperator bellow and the heat exchanger flange. it is normal to stretch the below 1-3 mm when tightening the V-clamp.

Note! Make sure that the flanges (14) and (15) are pressed tight together.

q) Fit the insulation (16) around the recuperator bellow (17) and the heat exchanger flange (18).



14 Flange (heat exchanger)
15 Flange (recuperator)
16 Insulation
17 Recuperator bellow
18 Heat exchanger flange

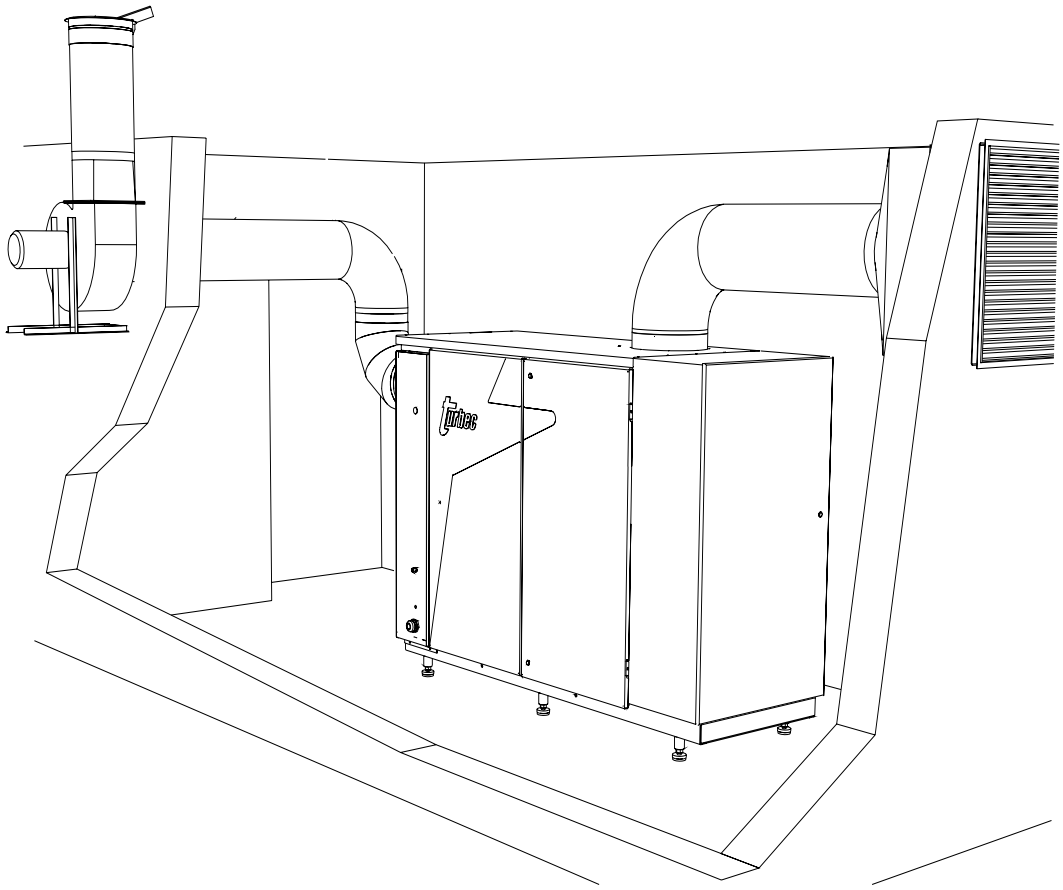
(Continued)

2.2T100s3_IM6_rev02.fm

6.5.3 Ventilation outlet installation

6.5.3.1 Ventilation outlet installation - T100 P

Dimension of connection:	Ø 315mm (12.4") male connection
Evacuation fan weight:	59 kg (130 lb), including mounting base
Connection type:	Sleeve coupling
Approximate air flow:	0.90 kg/s (=0.80 m^3/s) (1.98 lb/s =28.2 ft^3/s)



2.2T100s3_IM6_rev02.fm

Note! The ventilation outlet can be designed to be routed through roofing or through an outer wall.

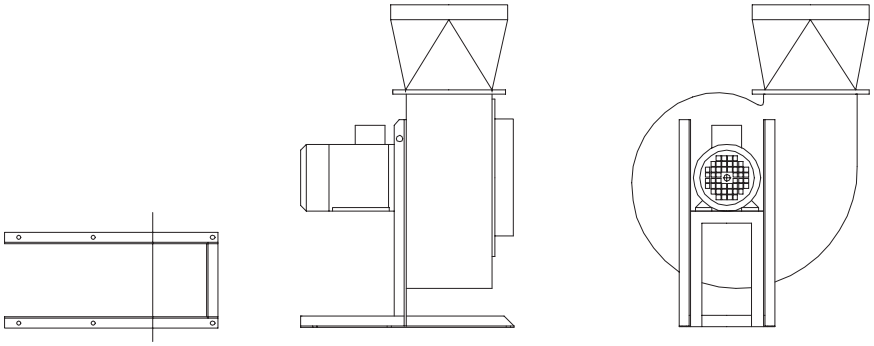
a) Install the evacuation fan between the T100 microturbine and the ventilation exit. The fan is designed for outdoor use.

Note! Turbec recommends to install the fan outdoors to reduce noise within the installation room, and as close as possible to the ventilation outlet.

(Continued)

(Continued)

The fan should be installed horizontally on its mounting base (included in Turbec's scope of supply). It is possible to change the air exit direction by mounting the fan shroud at other angles. Secure the mounting base with screws equal to three timed the weight of the fan unit.



Note! For safety reasons the evacuation fan can not be mounted on the T100 microturbine.

b) Install a duct, Ø 315mm (12.4") female connection, between the T100 microturbine and the ventilation system exit.

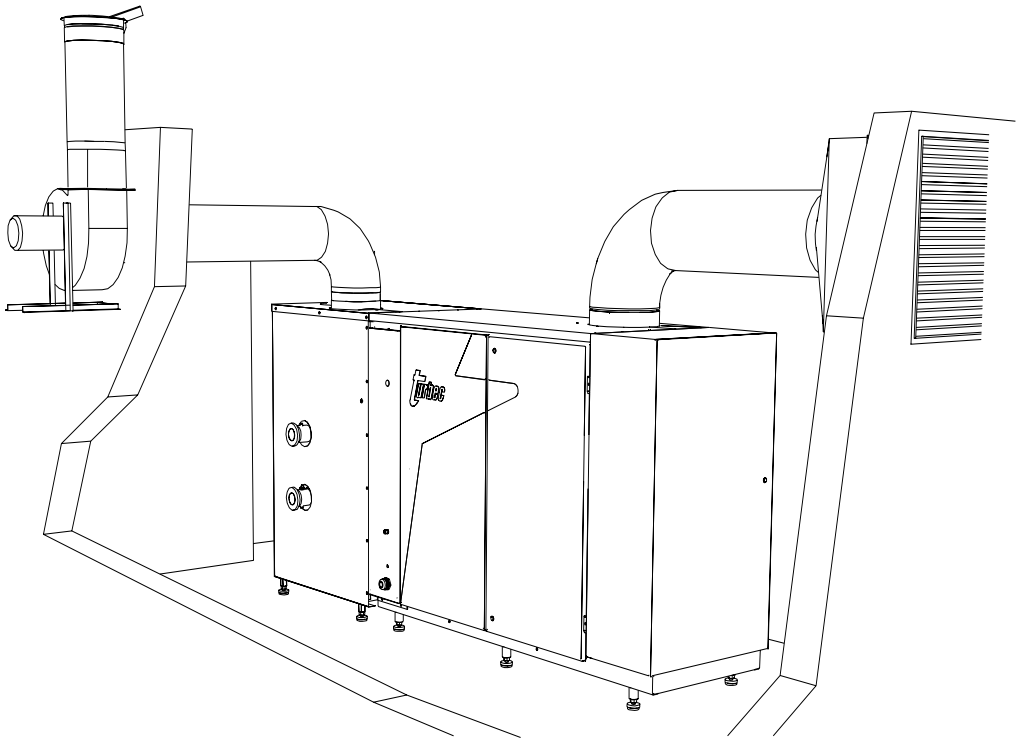
Caution! The flange on the T100 is not designed to carry any forces from the ventilation system. Extra weight, or forces, may seriously damage the machine.

Note! Design the ventilation outlet so that rain, snow or other objects cannot enter the T100 microturbine.
The ventilation pipe from the T100 to the evacuation fan must be designed for a maximum pressure drop of 120 Pa, for example 10 m, DN315 (12.4") and two bends, DN315.

2.2T100s3_IM6_rev02.fm

6.5.3.2 Ventilation outlet installation - T100 PH

Dimension of connection:	Ø 315mm (14.2"), male connection
Evacuation fan weight:	59 kg (130 lb), including mounting base
Connection type:	Sleeve coupling
Approximate air flow:	0.90 kg/s (=0.80 m^3/s) (1.98 lb/s =28.2 ft^3/s)



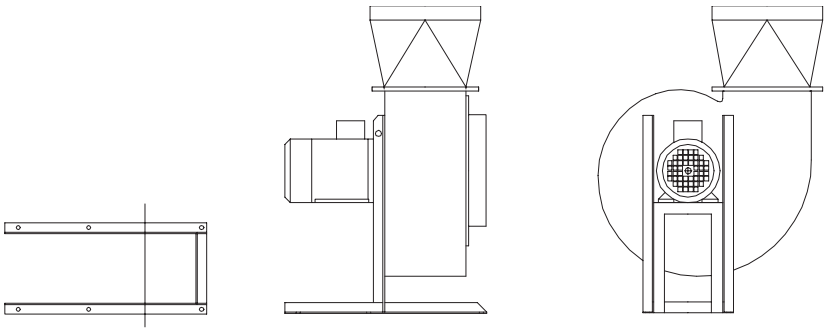
2.2T100s3_IM6_rev02.fm

Note! The ventilation outlet can be designed to be routed through roofing or through an outer wall.

a) Install the evacuation fan between the T100 microturbine and the ventilation exit. The fan is designed for outdoor use.

Note! Turbec recommends to install the fan outdoors to reduce noise within the installation room, and as close as possible to the ventilation outlet.

The fan should be installed horizontally on its base (included in Turbec's scope of supply). It is possible to change the air exit direction by mounting the fan shroud at other angles.

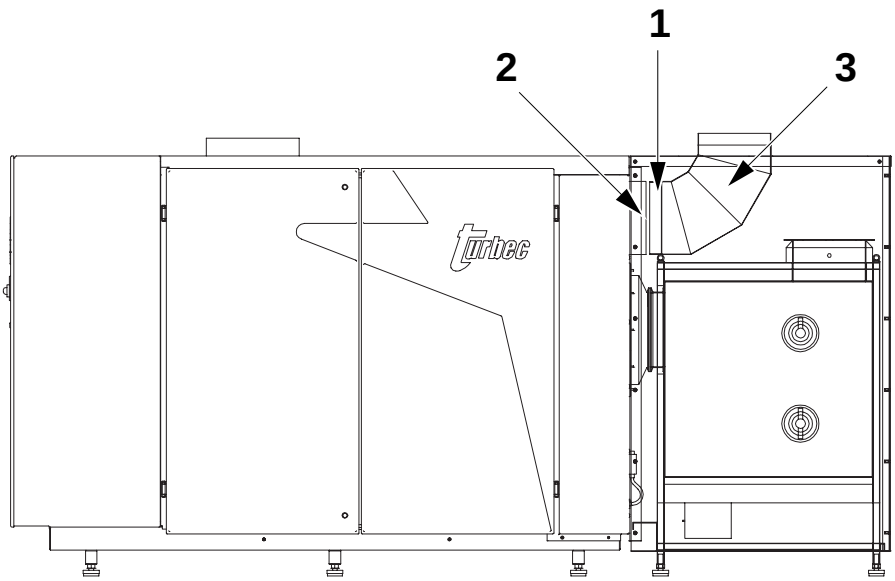


Note! For safety reasons the evacuation fan can not be mounted directly on the T100 microturbine in a indoor installation.

b) Fit the ventilation outlet adapter (1) (supplied by Turbec) to the ventilation air outlet (2).

c) Install the ventilation air outlet duct (3) (supplied by Turbec) to the ventilation outlet adapter.

1 Outlet adapter
2 Air outlet
3 Air outlet duct



d) Install a duct, Ø 315 mm (12.4")female connection, between the T100 microturbine and the ventilation system exit.

Caution! The flange on the T100 is not designed to carry forces from the ventilation system. Extra weight, or forces, may seriously damage the machine.

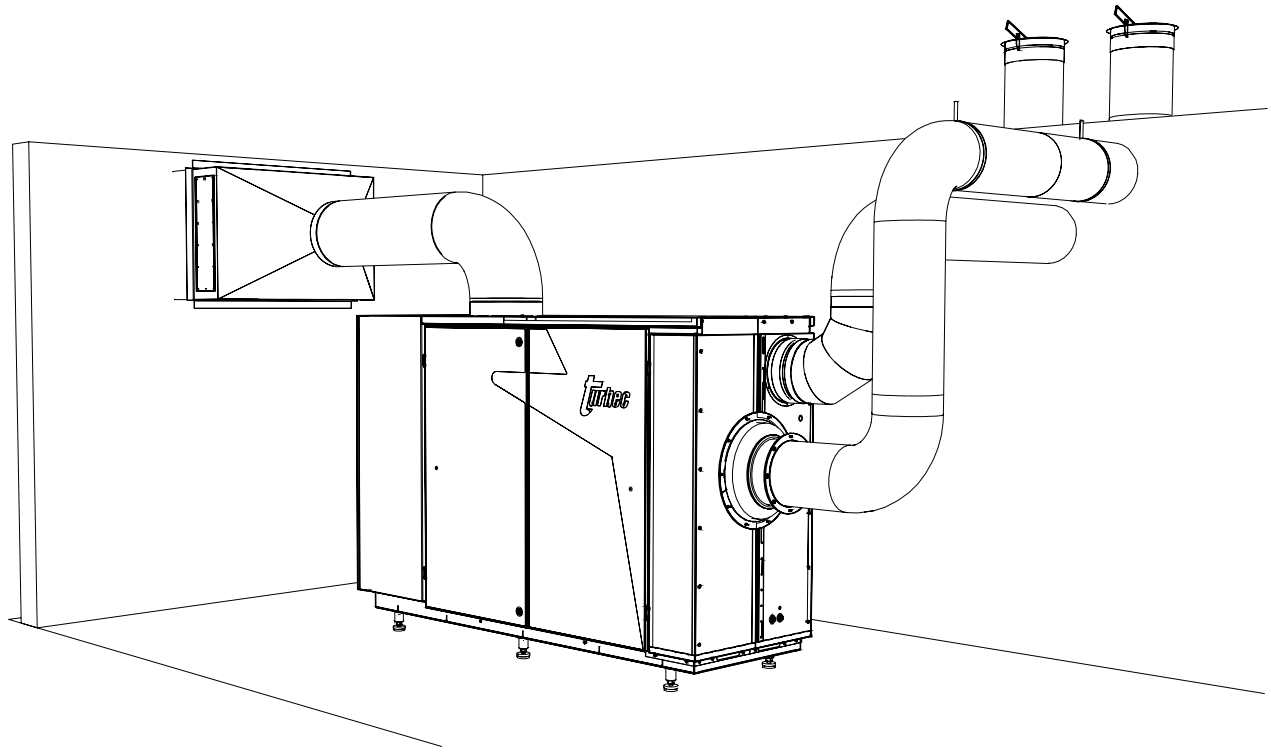
Note! Design the ventilation outlet so that rain, snow or other objects cannot enter the T100 microturbine.
The ventilation pipe from the T100 to the evacuation fan must be designed for a maximum pressure drop of 120 Pa, for example 10 m, DN315 (12.4") and two bends, DN315.

2.2T100s3_IM6_rev02.fm

6.5.4 Exhaust gas outlet installation

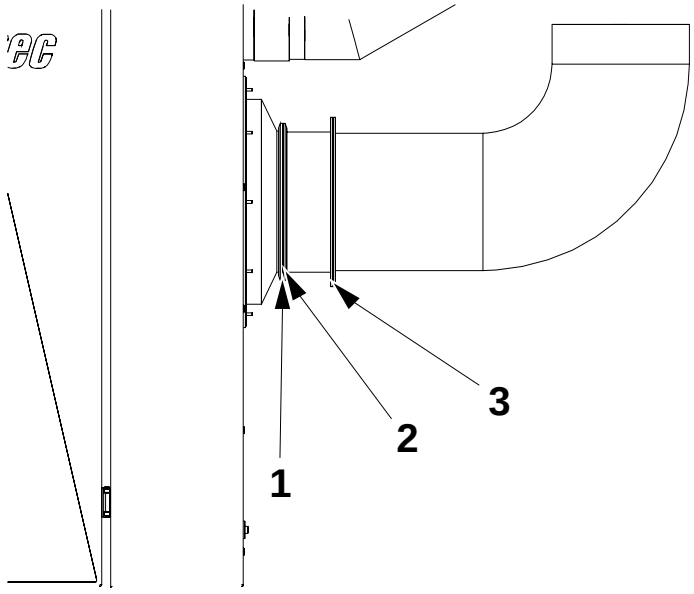
6.5.4.1 Exhaust gas outlet - T100 P

Type of connection:	Flange Ø 319 mm (12.55") inside diameter
Material of connection:	Black steel
Max exhaust gas flow:	0.87 kg/s (1.92 lb/s)
Max temperature:	325°C (612°F)



2.2T100s3_IM6_rev02.fm

The T100 P is delivered with a V-clamp (1), a gasket (2)and a spare flange (3) attached to the recuperator.



1 V-clamp
2 Gasket
3 Spare flange

(Continued)

(Continued)

a) Remove the V-clamp, gasket and spare flange from the recuperator.

b) Use super glue to fit the gasket to the recuperator exhaust gas outlet.

If the T100 is delivered with exhaust gas outlet pipes, please continue to d).

c) Mount the desired pipe to the spare flange.

Note! The required dimension for the connection of the pipe is Ø 319 mm (12.55”), inside diameter.

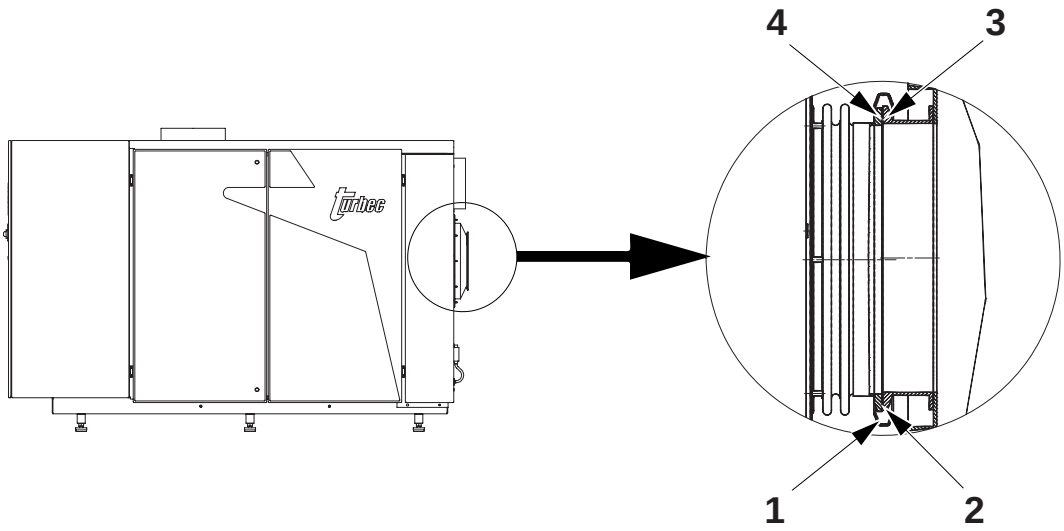
Caution! The T100 microturbine is not design to carry any extra weight on the exhaust gas pipe. Extra weight may seriously damage the machine

Note! Turbec recommends a ceiling mounted stress-relieve for the exhaust gas pipe. Please continue to e).

d) Fit the delivered exhaust gas outlet pipe to the recuperator bellow with the V-clamp.

e) Insulate the piping.

f) Fasten the V-clamp (1), with the gasket (2) in place, around the spare flange (3) and the recuperator flange (4).

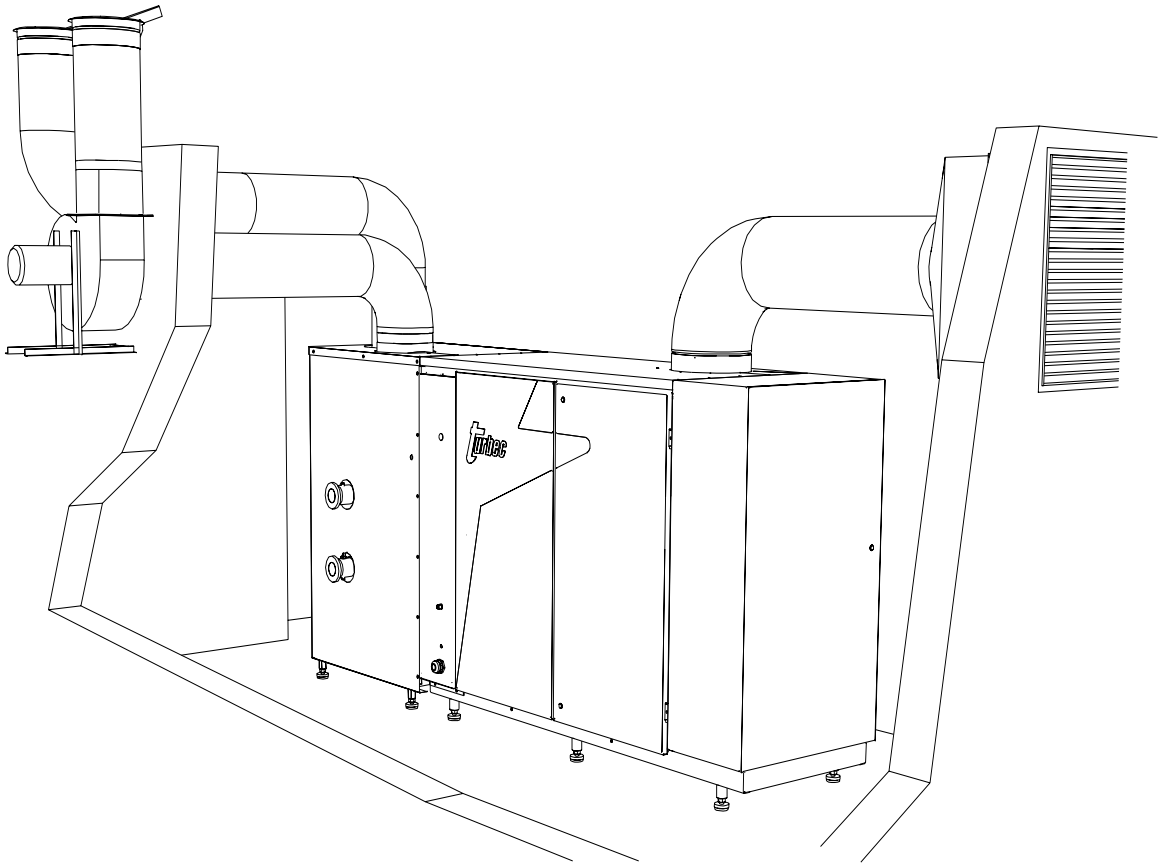


2.2T100s3_IM6_rev02.fm

1 V-clamp
2 Gasket
3 Spare flange
4 Recuperator flange

6.5.4.2 Exhaust gas outlet - T100 PH

Type of connection:	Flange, 8 bolt holes 8.5 mm Ø 356 mm (DIN 24154) (Flange, 8 bolt holes 7/16'', Ø 14'')
Material of connection:	Black steel
Max exhaust gas flow:	0.87 kg/s (1.92 lb/s)
Max temperature:	270 °C (518 °F)



2.2T100s3_IM6_rev02.fm

a) Install a pipe, Ø 315 mm (12.4") from the T100 microturbine to a chimney. Use material according to local standard.

Note! The exhaust gas outlet pipes must be designed for a maximum pressure drop of 250 Pa at 250 °C, for example 15 m, DN315 (12.4")and three bends, DN315 (12.4").

Caution! The T100 microturbine is not designed to carry any extra weight on the exhaust gas pipe. Extra weight may seriously damage the machine.

b) Insulate the piping.

Install an expansion bellow after the T100 interface. The chimney outlet has to be designed so that rain, snow or other obstacles cannot enter the T100 microturbine.

6.5.5 Heat exchanger enclosure

Caution! Protect the temperature sensor cables while mounting back cover. A damage to the cables may result in malfunction of the T100.

a) Fit the front and back covers (1) (5) to the mounting angles on the T100. Use a 5 mm Allen key.

b) Fit the right side cover (6). The right side cover must be placed behind the angle of the other 2 sides.

Note! Do not tighten the screws until the roof has been mounted.

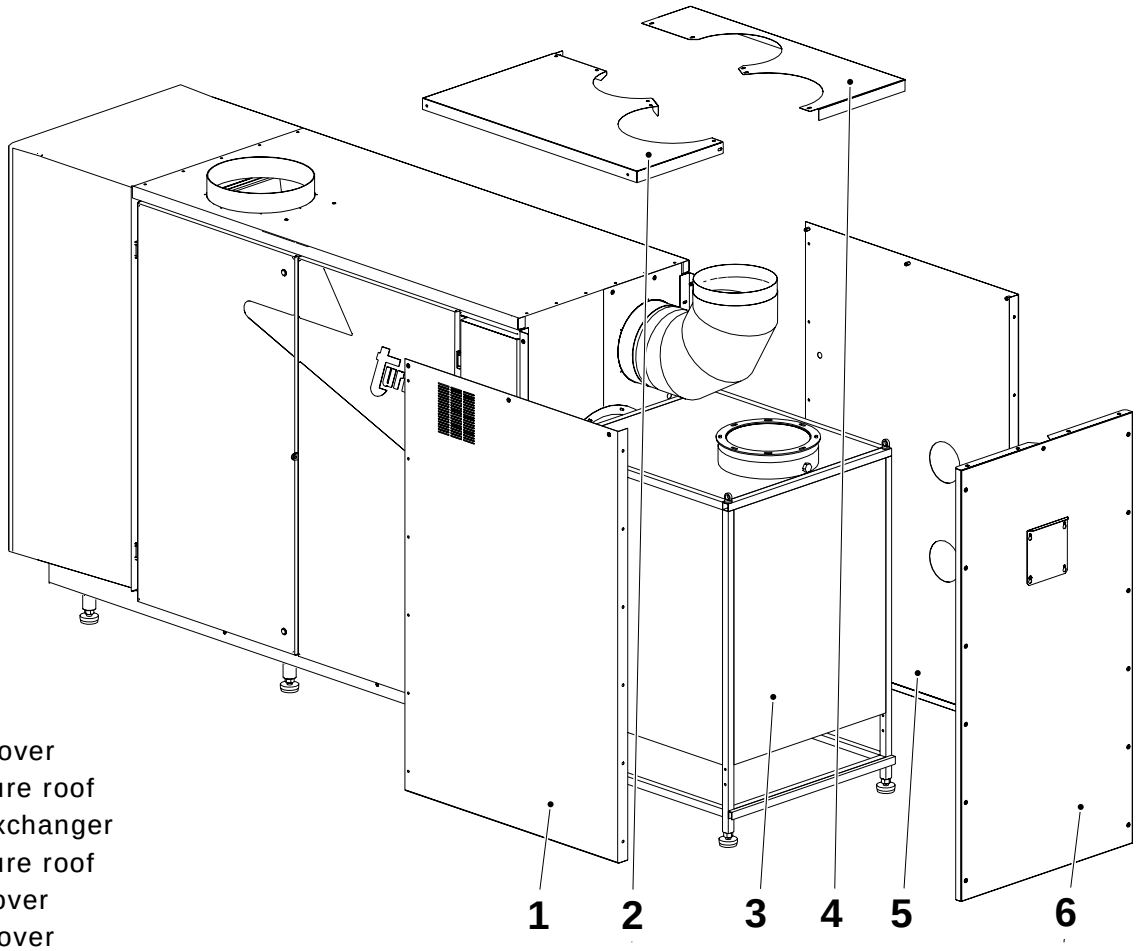
c) Fit the service side part of the enclosure roof (4).

d) Fit the backside part of the enclosure roof (2).

Caution! The heat exchanger enclosure roof is not designed to carry any extra weight. Extra weight may seriously damage the machine.

e) Tighten the screws on the right cover (6).

f) Tighten all screws on the enclosure.



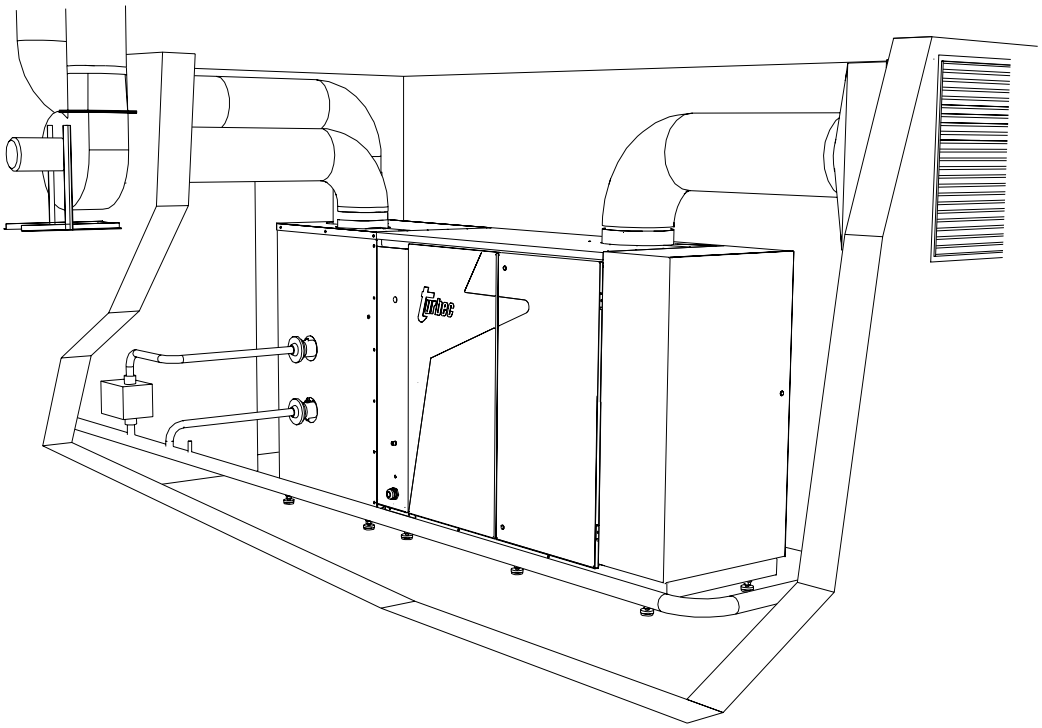
2.2T100s3_IM6_rev02.fm

1 Front cover
2 Enclosure roof
3 Heat exchanger
4 Enclosure roof
5 Back cover
6 Right cover

6.5.6 Hot water installation - T100 PH

Type of connection:	Flange, DN32, PN40 (DIN 2635) (1¼", ANSI B16.5, 300 lbs)
Min water temperature:	50°C (122°F)
Max water temperature:	150°C (302°F)
Max water pressure:	24 bar (g) (348 psig)
Min water flow:	1.5 l/s (0.40 gal/s)
Max water flow:	4 l/s (1.06 gal/s)

Example	
Water return temperature:	70°C (158°F)
Water forward temperature:	90°C (194°F)
Water flow:	1,77 l/s (3.75 ft^3/min)
Water pressure loss in exhaust gas heat exchanger:	33 kPa (4.8 psi) preliminary data



2.2T100s3_IM6_rev02.fm

Note! The hot water installation should be designed with respect to local legislation and standard for pressure and temperature.

Note! Isolation valves and an inlet strainer are mandatory.

(Continued)

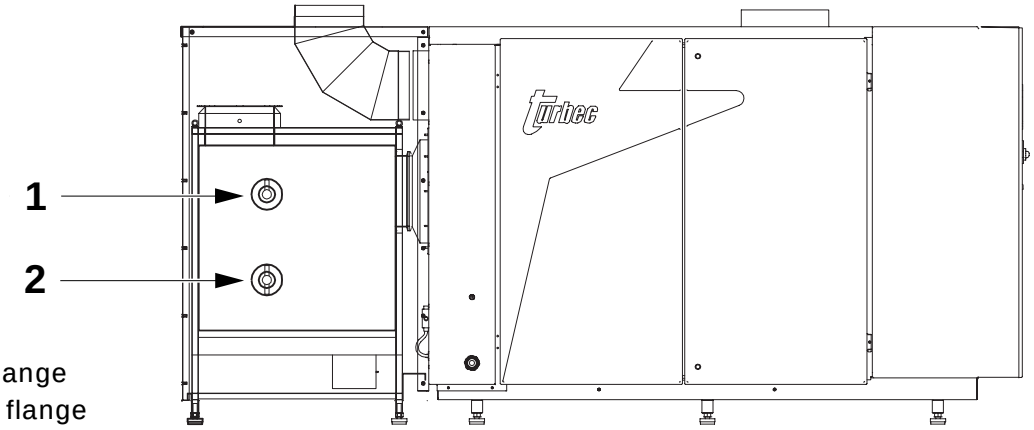
(Continued)

Note! Turbec Spa recommends that a safety valve, or an expansion tank, is installed between the isolation valve and the heat exchanger outlet.

a) Install a hot water circuit to the T100 microturbine. Connect the water circuit to the existing system's inlet pipe (1) and outlet pipe (2).

Caution! The T100 microturbine is not designed to carry any extra weight on its hot water pipes. Extra weight may seriously damage the machine.

Note! Install the inlet pipe on the top flange.



1 Inlet flange
2 Outlet flange

b) Install a water-circulating pump in the pipe system before the T100 microturbine. The min. flow of the pump is site specific. The electrical power feeding, including a motor over-heat protection rated 1.6-2.5A, is prepared on terminal in the T100 electrical cabinet, see details on section 7.

c) Purge the hot water circuit, see Operator's manual section: *7.4.2 Purge air from the exhaust gas heat exchanger.*

2.2T100s3_IM6_rev02.fm

6.5.7 Fuel gas installation

Type of connection:	Thread connection, 1½", female
Dimensions of gas piping:	at least 2" tubing, depending on supply pressure

Note! This installation is not valid if the T100 microturbine is connected to a high pressure gas grid (>6 bar (g)).

Note! The fuel gas installation is subject to local regulations in most countries and must be adapted to the standards and regulations in each country. This installation is adapted to a low pressure grid.

Note! Turbec recommends that a manual cut off valve (included in scope of supply) is installed before the T100 microturbine inlet.

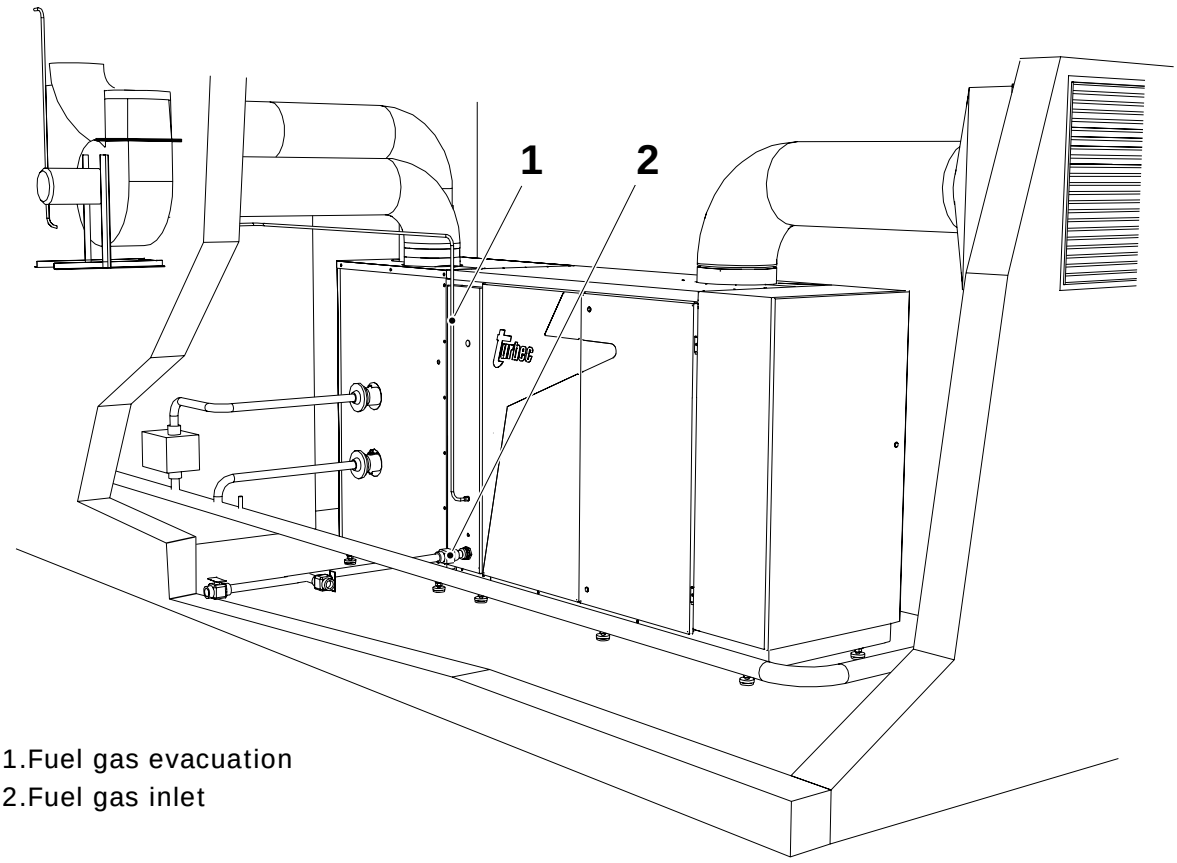
WARNING!

Risk of personal injury!
Natural gas is asphyxiating and inflammable.

The fuel gas evacuation outlet is a Zone 1 area (according to EN 60079-10). For definition, see *section 2.5.1.1 Definitions (according to IEC/EN 6079-10):* in *section 2. Safety precautions*.

a) Install natural gas piping routed from the low-pressure system to the T100 microturbine. Install a purge valve on the pipe close to the manual cut-off valve. A flexible tube with a minimum length of 250 mm (9.85") is recommended closest to the T100 microturbine inlet.

2.2T100s3_IM6_rev02.fm



1.Fuel gas evacuation
2.Fuel gas inlet

(Continued)

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Note! The gas piping to the T100 must be dimensioned such as the gas pressure, even at full load do not fall below 20 mbar (40 Nm^3/h) at the inlet of the T100.

Install a 10 mm (0.40”) pipe for fuel gas evacuation, routed from the T100 microturbine and connected to the outside of the building according to applicable local legislation. The exit of the fuel gas evacuation piping must be located 1.5 m (59”) away from any means of ignition, such as hot surfaces and electrical installations.

WARNING!

Risk of personal injury

Any installation works concerning the fuel gas system shall be completed by checking for gas leakage outside the T100 microturbine and its remote fuel gas system. Carefully follow the local instructions and gas regulations.

The leakage test can be performed with a gas sniffer.

6.6 Outdoor installation

6.6.1 Outdoor air intake module

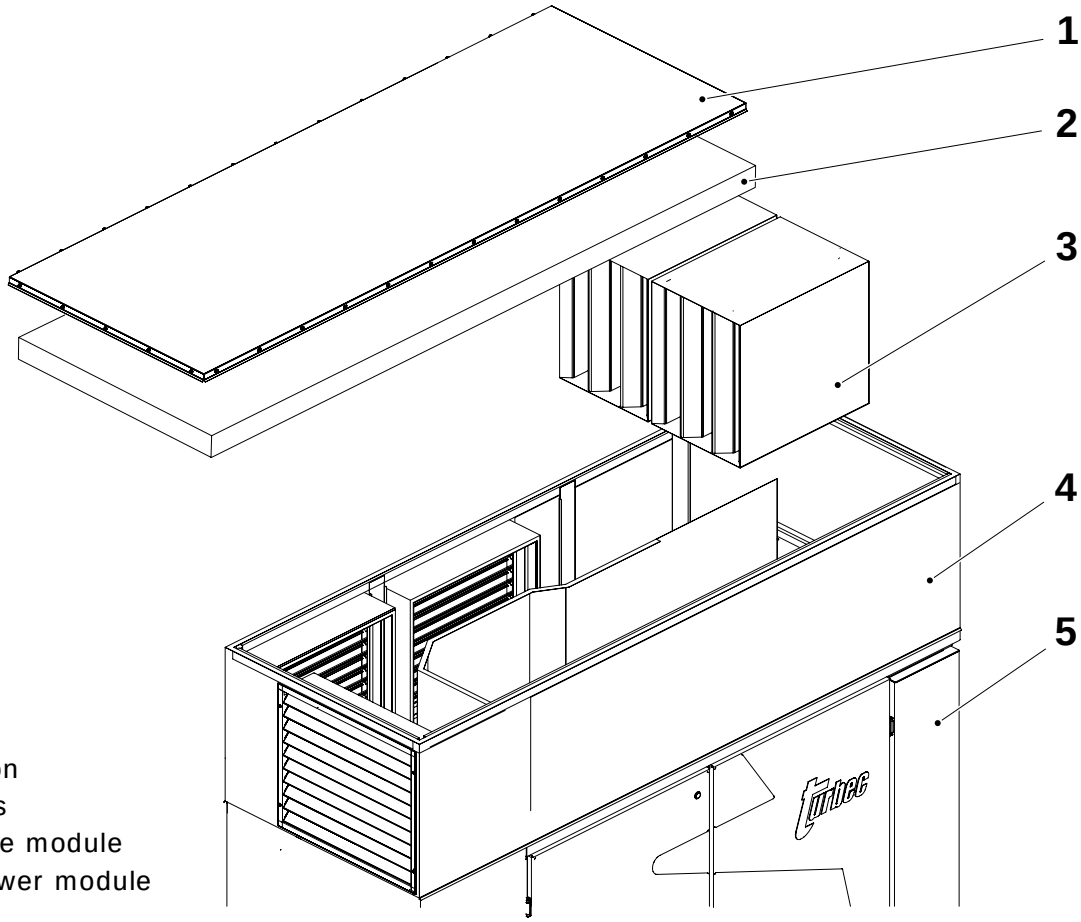
a) Remove the roof (1) from the outdoor air intake module (4) by removing the 8 mm screws.

b) Remove the insulation (2).

c) Remove the two silencers (3).

d) Remove the screws (6 pcs) on the exhaust side of the roof of the T100 Power module (5), and the screws, except the rear one,(4 pcs) on the cabinet side.

e) Lift the outdoor air intake module (4) onto the roof of the T100 Power module (5).



1. Roof
2. Insulation
3. Silencers
4. Air intake module
5. T100 Power module

f) Fit the air intake module (4) to the T100 Power Module (5) roof with the screws. Use a 5 mm Allen key.

g) Fit back the silencers (3).

h) Fit back the insulation (2).

i) Fit back the roof (1) to the outdoor air intake module (4).

2.2T100s3_IM6_rev02.fm

6.6.2 Evacuation fan installation

a) Fit the mounting angles (4) to the T100 Power Module.

b) Fit the fan bracket (1) to the T100 Power Module.

c) Remove the upper section (7) of the evacuation fan (5).

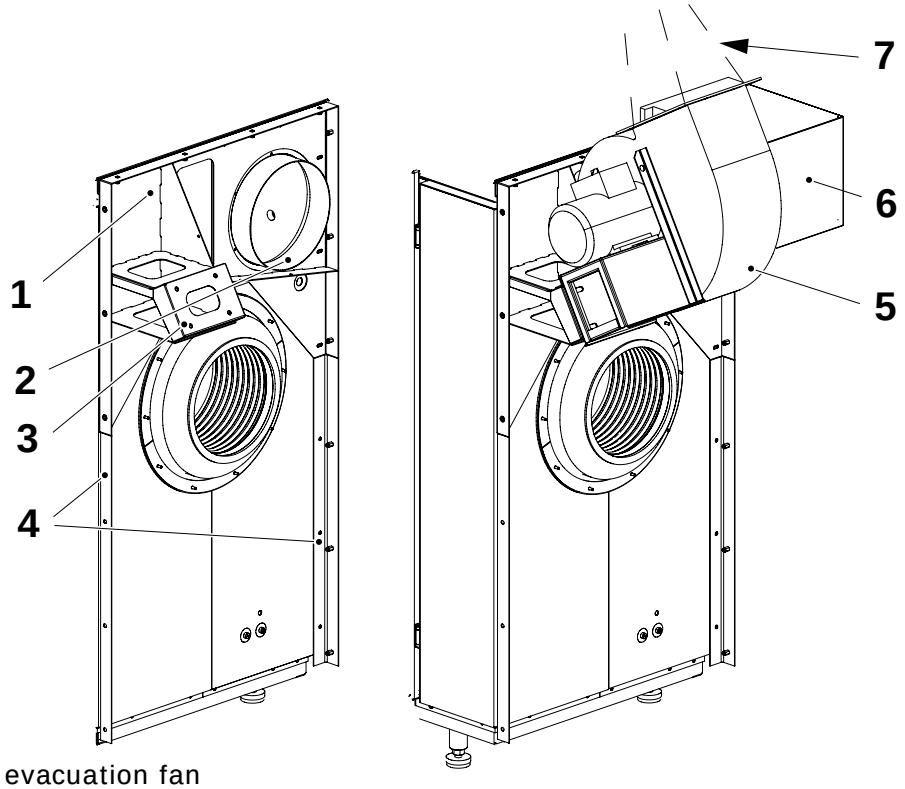
d) Fit the adapter (6) to the ventilation outlet (2) on the T100 Power Module.

e) Mount the evacuation fan (5) to the fan bracket plate (3).

f) Fit the mounting clips between the adapter (6) and the evacuation fan (5).

g) Connect the evacuation fan (5).

h) Connect the electric power feeding cable to the connector below the exhaust air outlet on the T100 panel (8).



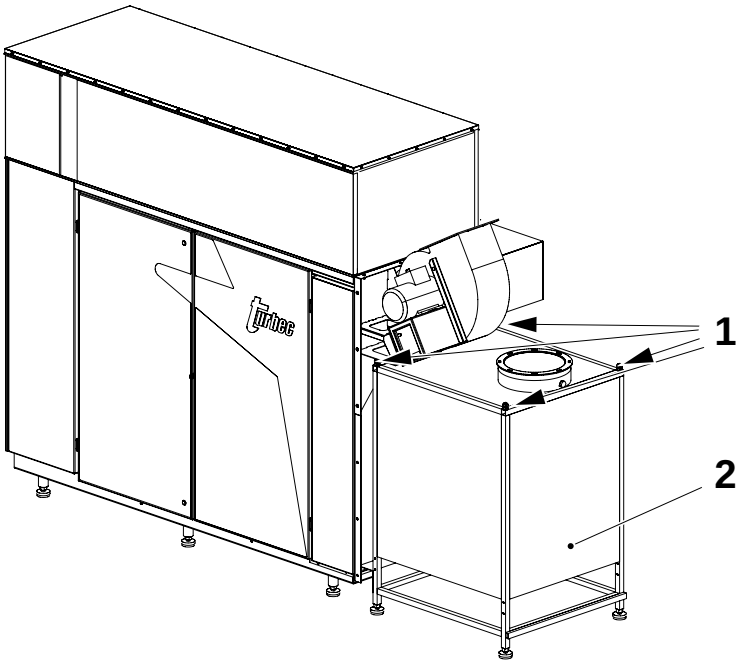
1. Fan bracket
2. Ventilation outlet
3. Plate
4. Mounting angles
5. Evacuation fan
6. Adapter
7. Upper section
8. Electrical connector to evacuation fan

2.2T100s3_IM6_rev02.fm

6.6.3 Heat exchanger installation - T100 PH

See *section 6.5.2 Heat exchanger installation - T100 PH*.

Note! Remove the lifting eye bolts (1) from the heat exchanger (2).



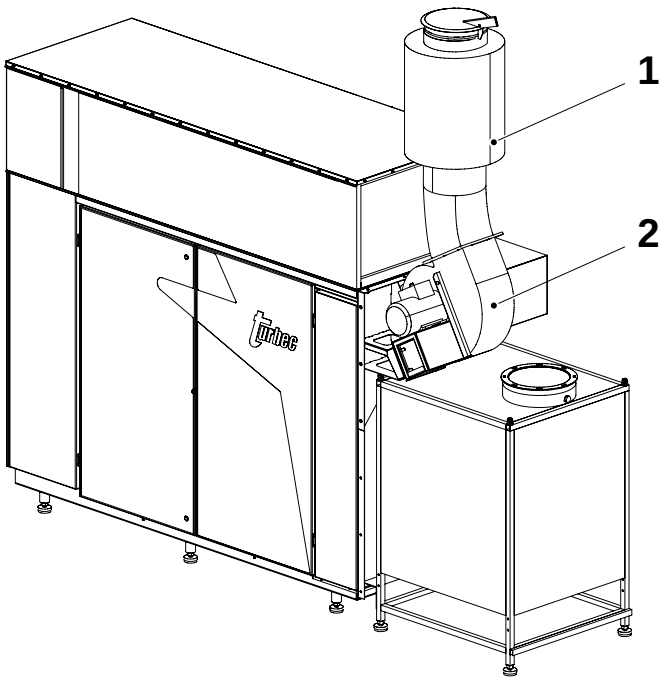
1. Lifting eye bolts
2. Heat exchanger

2.2T100s3_IM6_rev02.fm

6.6.4 Ventilation outlet installation

a) Fit the ventilation silencer (1) to the evacuation fan (2)

Note! To protect the insulation, put a plank on the top of heat exchanger for personnel to stand on while mounting.



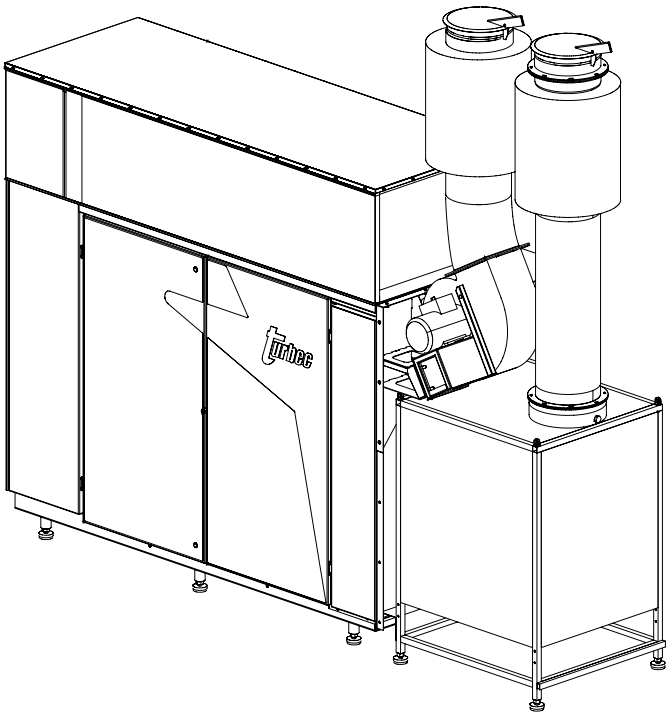
1. Silencer
2. Evacuation fan

6.6.5 Exhaust gas outlet installation

6.6.5.1 Exhaust gas outlet -T100 PH

a) Fit the exhaust chimney to the exhaust gas outlet on the heat exchanger

Note! To protect the insulation, put a plank on the top of heat exchanger for personnel to stand on while mounting.



2.2T100s3_IM6_rev02.fm

6.6.5.2 Exhaust gas pipe assembly -T100 P

a) Attach backside stand (10) to long bars (9).

b) Attach short bars (3) and (7) to backside stand (10).

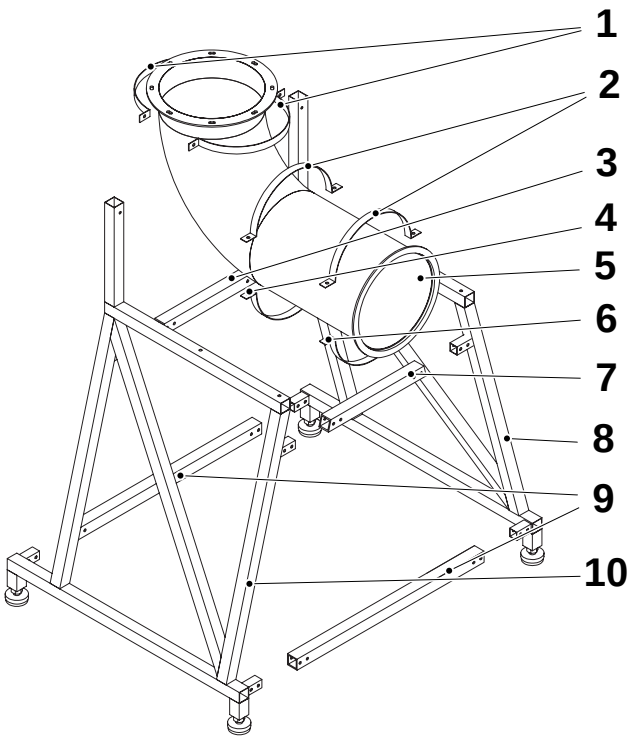
c) Attach bars (3), (7) and (9) to front side stand (8).

d) Attach clamps (4) and (6) to stand.

e) Fit bend (5) to stand.

f) Attach clamps (1) to assembly.

1 Clamps
2 Clamps
3 Short bar
4 Clamp
5 Bend
6 Clamp
7 Short bar
8 Front side stand
9 Long bar
10 Back side stand



2.2T100s3_IM6_rev02.fm

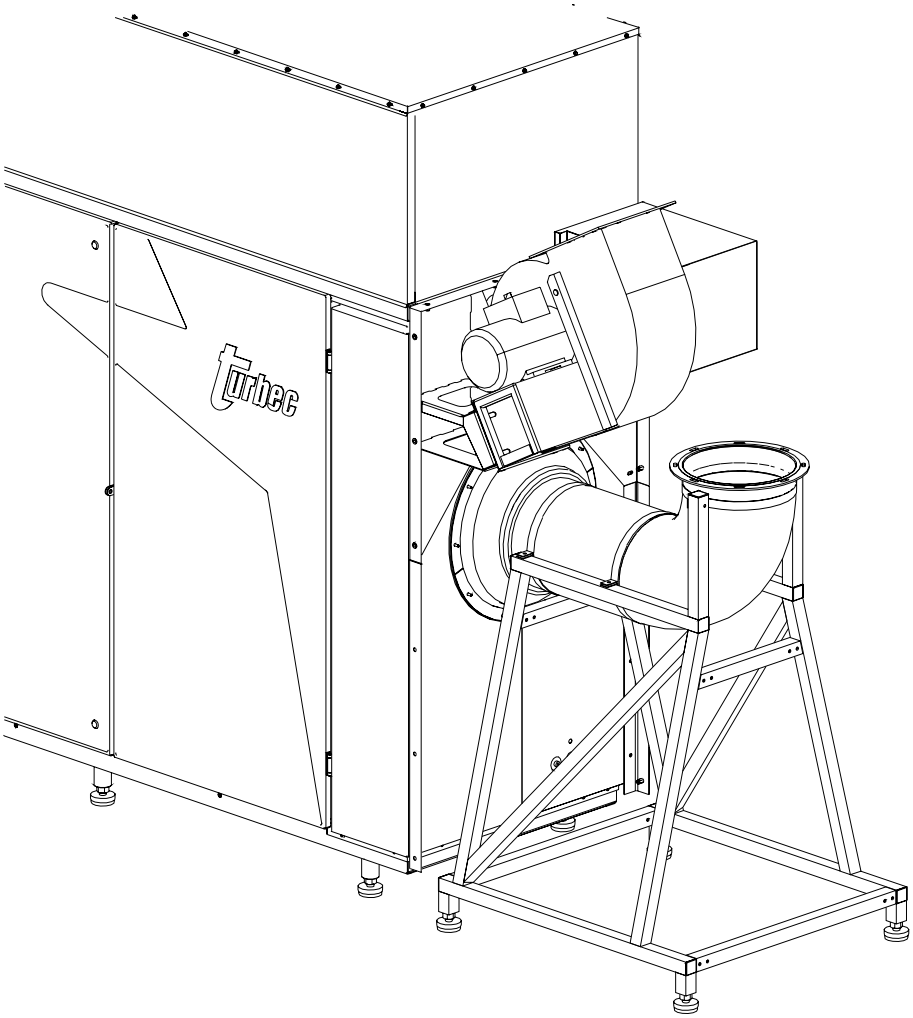
6.6.5.3 Exhaust gas outlet installation - T100 P

Follow instructions in section *6.5.4.1 Exhaust gas outlet - T100 P*

a) Fit exhaust gas pipe assembly to recuperator flange.

b) Fit the exhaust chimney to the exhaust gas outlet on the pipe assembly.

Note! Stand on the gas pipe assembly while mounting.



2.2T100s3_IM6_rev02.fm

6.6.6 Heat exchanger enclosure

a) Fit the enclosure covers (5) to the mounting angles on the T100. Use a 5 mm Allen key.

b) Fit the right side cover (4). The right side cover must be placed behind the angle of the other 2 sides.

Note! Do not tighten the screws until the outlet covers has been mounted.

c) Fit the cover flanges on the water circuit connections.

d) Fit the outlet covers (2) to the mounting angles on the T100. Use a 5 mm Allen key.

e) Fit the right side outlet cover (3). The right side cover must be placed behind the angle of the other 2 sides.

f) Fit the front side part of the enclosure roof (1).

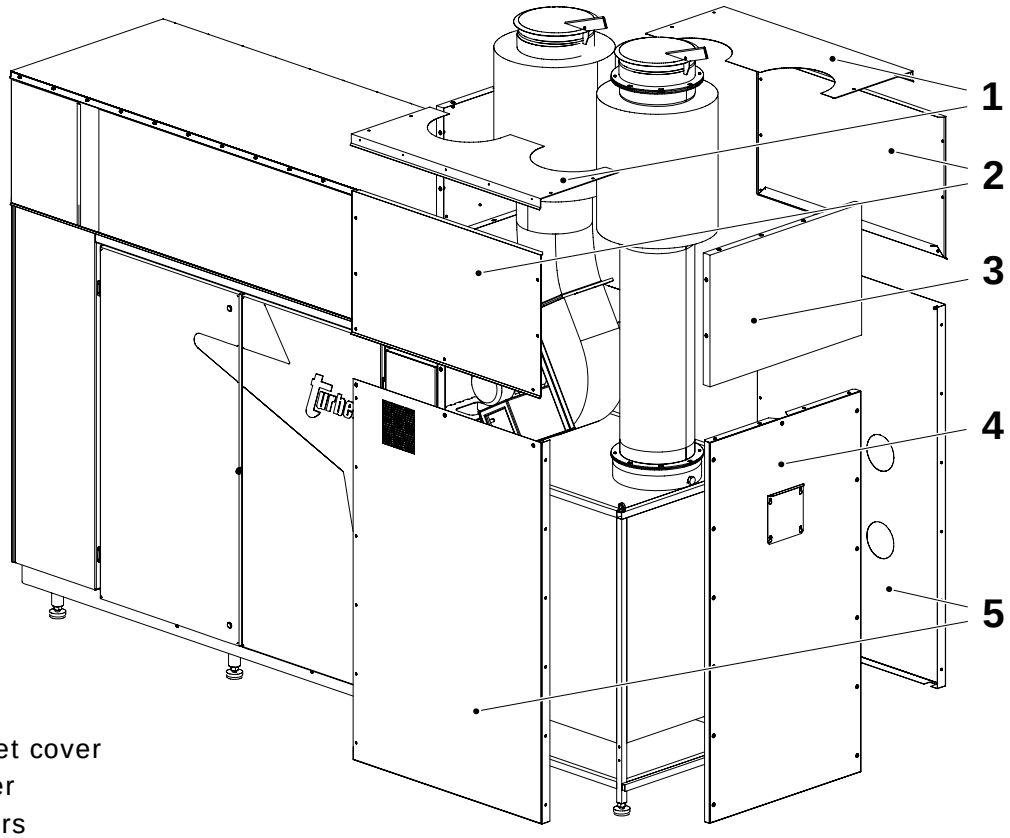
g) Fit the backside part of the enclosure roof (1).

Caution! The heat exchanger enclosure roof is not designed to carry any extra weight. Extra weight may seriously damage the machine.

h) Tighten the screws on the enclosure backside (6).

i) Tighten all screws on the enclosure

2.2T100s3_IM6_rev02.fm



1 Enclosure roof
2 Outlet cover
3 Right side outlet cover
4 Right side cover
5 Enclosure covers

6.6.7 Hot water installation - T100 PH

See *section 6.5.6 Hot water installation - T100 PH*.

In case of a possible risk of minus degrees, proper actions must be taken to prevent freezing water in case the unit is not run. Different possible solutions are isolation of the water pipes, means of heating, means of draining the system, etc.

6.6.8 Chimney stabilizing

a) Mount long bars (1) on the top of the chimneys (4).

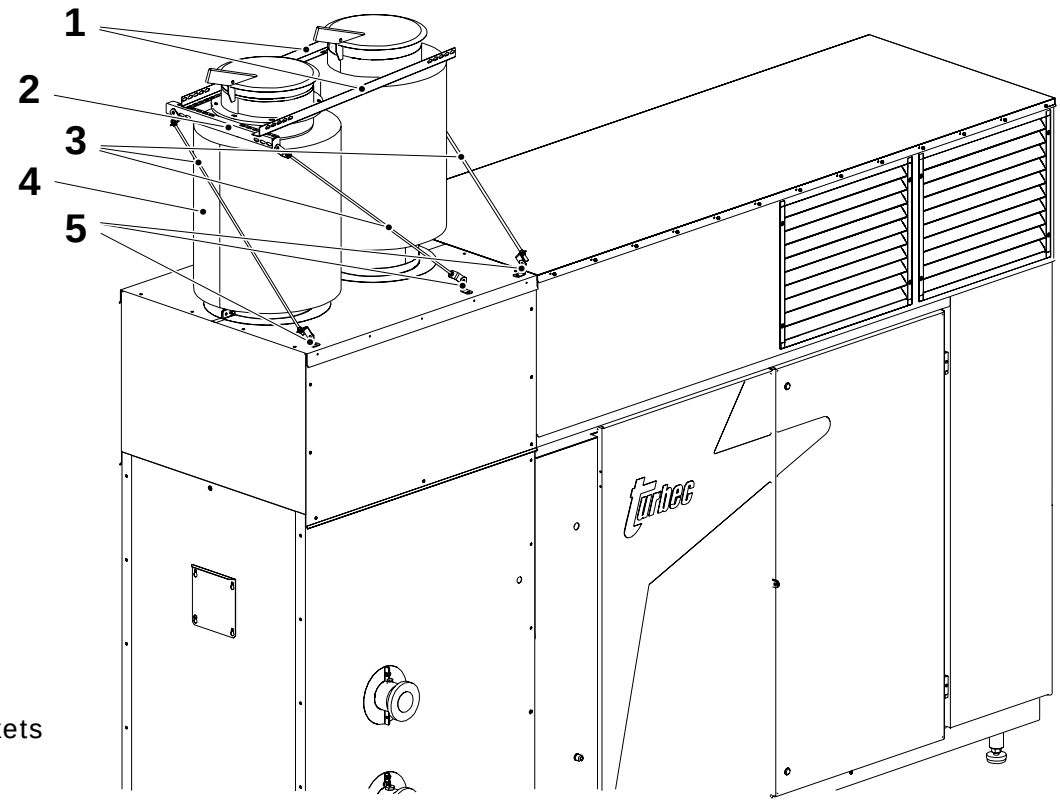
b) Mount short bar (2) to the long bars (1).

c) Fit angle bracket (5) to roof top.

d) Mount rods (3) to angle brackets (5).

e) Fit rods (3) to angle brackets at the end of the bars

f) Adjust rods until the chimneys are straight



2.2T100s3_IM6_rev02.fm

1. Long bars
2. Short bar
3. Rods
4. Chimneys
5. Angle brackets

7. Electrical installation

2.2T100s3_IM7_rev02.fm

7.1 General requirements

7.1.0.1 Personnel

Only qualified installation personnel are authorized to assemble the T100 microturbine. See *section 2. Safety precautions* for definition of qualified installation personnel, *section 2.2 Personnel*.

See also *section 6.1 General requirements* for further details.

7.2 Overview

7.2.1 General information about cable dimensioning

Nominal voltage:	3x400 VAC
Maximum continuous current:	173 A
Maximum short circuit current produced:	270 A rms / 5 milliseconds
Maximum short current allowed from the electrical net into the T100:	35 kA

There are different aspects to the design of the electrical grid connection for the T100 microturbine. Most of them are given by the T100 microturbine, but not all.

Note! Make sure that the installation complies with the local legislation and standards.

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7.2.2 Power grid connection

The T100 is equipped with an ABB SACE S3N250FF circuit breaker (EAQ1) which the grid cables are to be connected to.

The T100 main circuit breaker is not to be regarded as an isolation switch according to all international standards. Therefore, the installation must provide an isolating switch, removable fuses or similar, preferable close to the T100.

7.2.2.1 Power grid connection - T100 P/PH

Connect the T100 to a system with nominal rated phase to phase voltage of 400 VAC. The neutral is never used by the standard T100, and the connection of it is therefore never needed.

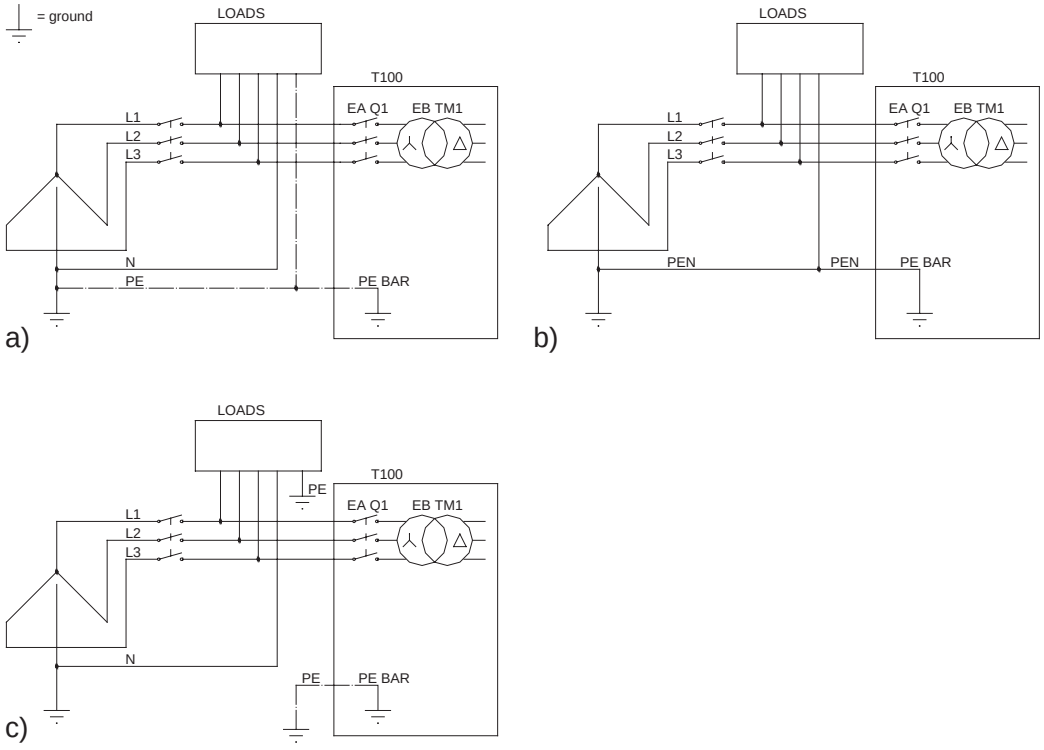
For a three phase grid system (a), the star point of the Y must be connected to the ground. This ground is to be supplied to the T100.

If the T100 is connected to a 4 wire connection system (b), the protected ground wire (PE) and the neutral wire (N) are combined into a PEN wire.

The safety ground to the T100 can be locally created (c).

The T100 electrical system is designed to break a short circuit current up to 35 kA provided from the grid to the T100. The short circuit current capability of the grid must be checked before installation of the T100.

Note! If the short circuit current exceeds the given values, Turbec must be contacted.



2.2T100s3_IM7_rev02.fm

7.2.3 Overall topology of the T100 protection

7.2.3.1 Overall topology - T100 P/PH

The T100 supply several safety systems that disconnect the T100 from the grid in case of a fault.

The grid cables are connected to the T100 main circuit breaker, which is a manually operated circuit breaker. In case of work on the power connection to the T100 this must be opened and locked to prevent the T100 from generating power to the grid. The circuit breaker also gives a thermal over current protection and a short circuit protection.The power electronics includes a voltage protection to protect itself. The levels are about +/- 10% of the nominal grid voltage and the release time is about 50-100 milliseconds.

In the same way, the power electronics provides a frequency protection with trip limits at about +/- 0.3 Hz.

Finally, the power electronics also has a over current protection that will trip the unit in case about 300 A is provided for more than 50 milliseconds.

Note! Wait for at least 1 minutes after opening the T100 main circuit breaker before work inside the cabinet is started. This ensures the capacitors to discharge.

Note! The circuit breaker short circuit protection will not open the breaker in case there is a short circuit outside the T100 as the maximum short circuit current produced by the T100 is less than the limits in the breaker.

A contactor (TAKM02) is connected between the circuit breaker and the power electronics. This can be opened by hardway by either the emergency stop buttons or an external signal.

The external control signal can be used together with an external relay protection/ loss of grid detection system. The T100 is also prepared with a feedback signal giving the status of the contactor (TAKM02). This is needed in case of relay protection testing.

The T100 is prepared with one Emergency Stop button located nest to the operators panel. It is also prepared for connection of an optional external Emergency Stop button if so required.

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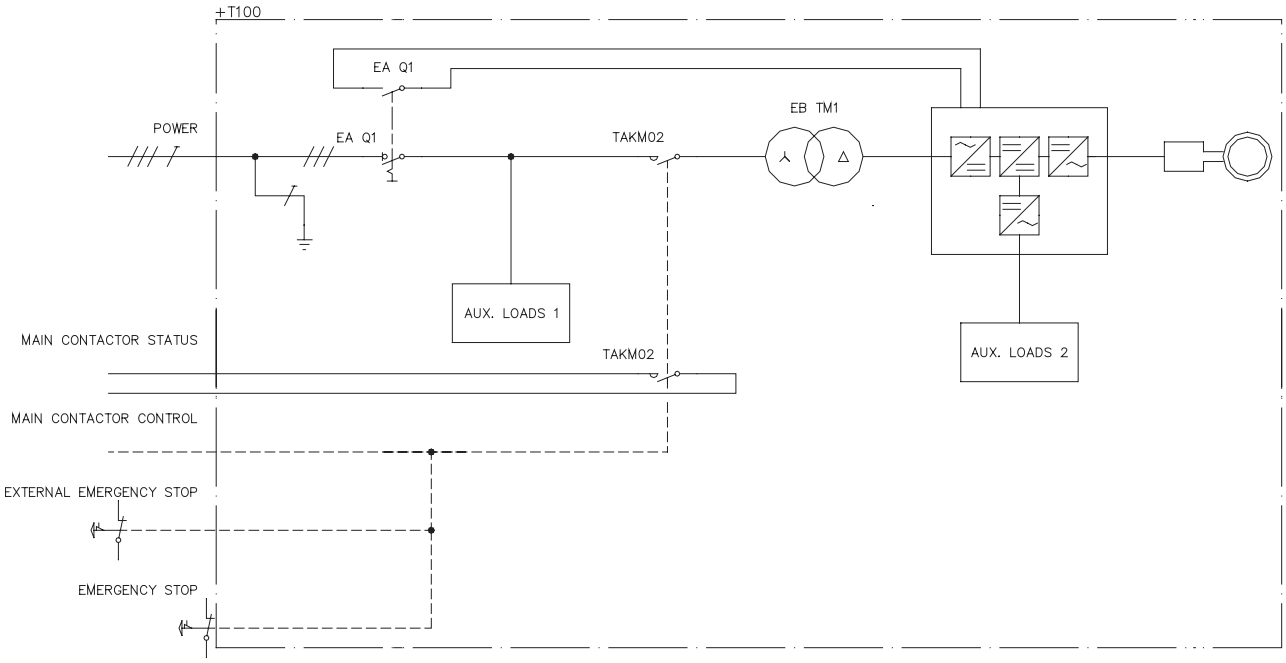

7.2.3.2 Protection external to the T100

Any protection, accepted by the utility which supplies a potential free open/ closed signal* can be used in the installation. The optional free signal is fed to the T100 and will, with hardware, open the contactor.

A skilled and experienced electrician may recommend an alternative installation. The electrical system is subject to several site-specific demands. Those are both technical and regulatory, and have to be adapted to the standards and regulations in each country.

* open signal=open T100 contactor

7.2.3.3 Relay protection to be mounted in the T100 cabinet

Space inside the T100 electrical cabinet is given to be able to fit the external relay protection. The distance for the cables to the T100 output contactor is in this case minimized. This can be beneficial in single unit installation.

Please contact Turbec for delivery, or suggestion of relay protection.

7.2.4 Selectivity

It is necessary to obtain selectivity between the T100 microturbine´s circuit breaker and the distribution grid. Check that the fuse, or breakers, in the grid will disconnect after the main switch in the T100 is disconnected. The T100 is delivered with a default setting. Check these settings at the installation, and compare the current-time tripping curve of the main switch breaker with the same data for the fuses and breakers in the grid.

7.2.5 Maximum voltage

There is an over voltage protection in the T100 power electronics. If the voltage amplitude rises above the limits rises above the limit 110% of the nominal voltage, the protection will trip the T100. Be aware that protection devices may trip if connected to a weak (high impedance) grid. The output current from the T100 will increase the grid voltage to a level above the voltage amplitude before generation. The level of voltage increase depends on the grid impedance and the T100 output current. If this level is too close to the allowed limits before generation is started, this may result in tripping of the T100 microturbine when the T100 is running.

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7.3 Connecting to the electrical distribution grid

7.3.1 Cable overview

This cable overview shows general information about what electrical cables should be connected to the T100 for power generation output. It also shows general information about various signal cables for measuring and control. Exactly what signals are needed depend on the site, and the functions being used. Further details are also given in section 7.3.3.

Note! Cables with multiple wires are to be used if possible.

☒ = The cable is used for this variant of the T100

☐ = The cable is optional for this variant of the T100

7.3.1.1 Cables with voltage above 50 V_{rms}

Connection point	Cable	P	PH	Optional
AC Power grid	Grid cables	☒	☒	No
Water pump in heating system	Water pump		☐	Yes [1)]
Evacuation fan	Evacuation fan power	☒	☒	No

[1)] To feed a water pump whitin the ratings 1.6-2.5 A. For other ratings a control signal is supplied.
Either this power connection or the signal must be used as the external pump always is needed

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7.3.1.2 Cables with voltage under 50 V_{rms}

Connection point	Cable/wire	P	PH	Optional
Heat exchanger	By-pass motor power		☐	Yes [3]
Water heating system	Customer water temperature		☒	No
	Water pump		☐	Yes [4]
	Customer boiler output temperature		☐	Yes
Switch gear	Enable main output contactor	☐	☐	Yes [5]
	Main output contactor status	☐	☐	Yes
	Grid healthy	☐	☐	Yes
	Produced Electrical Energy	☐	☐	Yes
	Site imported electrical active power	☐	☐	
	External T100 Emergency stop	☐	☐	Yes
	Indicate T100 Emergency stop	☐	☐	Yes
Building Management System (BMS)	T100 Start/Stop	☐	☐	Yes
	Indicate T100 Alarm	☐	☐	Yes
	Indicate T100 Running	☐	☐	Yes
	T100 Active power reference	☐	☐	Yes
	T100 Reactive power reference	☐	☐	Yes
	External fail	☐	☐	Yes
Miscellaneous	AI Spare 1	☐	☐	Yes
Miscellaneous	AI Spare 2	☐	☐	Yes
Miscellaneous	AO Spare 1	☐	☐	Yes
Miscellaneous	+24 V to external components	☐	☐	Yes
Phone line		☒	☒	No [6]
Data network (Ethernet)		☐	☐	Yes

[2] To feed the by-pass motor on the heat exchanger, if by-pass is used

[3] The T100 is supplied with a surface mounted PT100 sensor to be used. Some extension cables are needed.

[4] To control the water pump outside the T100. Either this signal or the power connection must be used in all T100 PH units (as the external pump always is needed)

[5] To open the T100 main contactor by hardware to prevent power output, for example to be connected to external relay protections

[6] To enable remote communications with the T100. To some extent optional depending on the outline of the service agreement or usage of a GSM modem (option).

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Cables supplied by Turbec

Connection point	Cable/wire	P	PH	Optional
Evacuation fan		☒	☒	No [7]
Temperature sensor			☒	No
By-pass motor			☐	Yes

[7] In outdoor units, a cable to the evacuation fan is supplied. The evacuation fan is mounted directly on the T100, why not extra cable or connector is needed. In outdoor units, a cable of 3 m is supplied. Since the distance to the evacuation fan is site specific, the supplied cable may be too short. If a connection of another cable is made, a proper connection of the EMC shield must be done. In both cases, the power cable is to be connected to the T100 connector below the exhaust air outlet pipe.

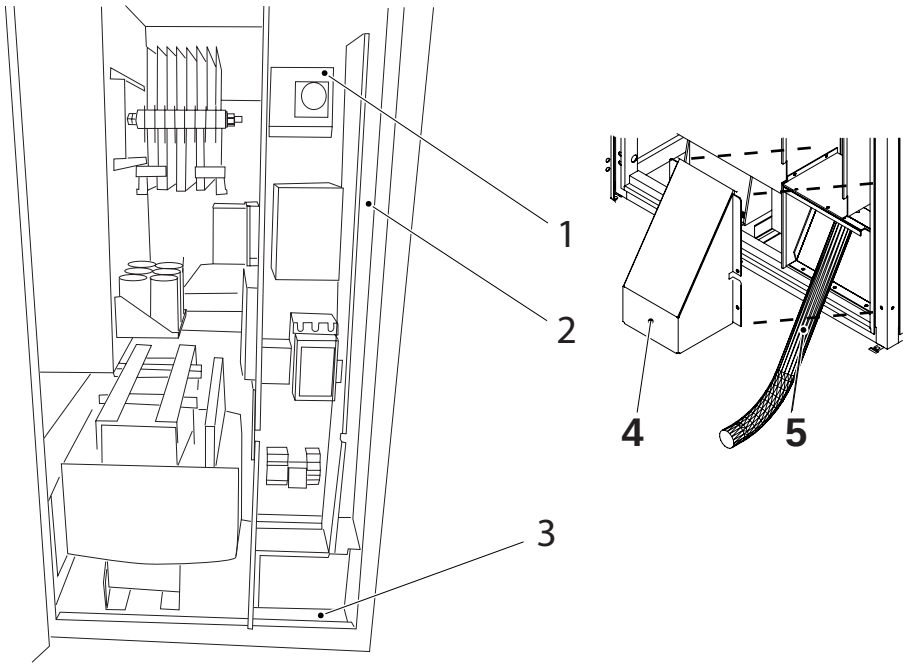
7.3.2 Cable entry

All the cables to the T100 are led to the machine through a cable entry area in the top of the electrical cabinet (indoor unit) or in the bottom of the cabinet (outdoor unit).

Remove the cable entry plate and punch holes with the dimension according to the specification of the cable glands chosen (not included in the Turbec delivery). Mount the glands on the plate, mount the plate on the T100 and pull the cables through the glands. Make sure that the glands are properly tightened.

The phases are to be connected directly on the circuit breaker EA Q1 and the safety ground is to be connected on the ground bar. Use cable lugs on both power and ground cables. If bottom entry is used, put the power cables in the channel to the right in the cabinet. Make sure all three phases and the safety ground are properly attached and fastened.

All cables except the power cables and safety ground are to be connected to the customer interconnection terminal X1 located in the control part of the electrical cabinet. Pull the cables from the cable entry plate to this control section via the lower part of the cabinet.



1 EA Q1
2 Cable corridor
3 Outdoor entry for cable
4 Cable hood
5 Cable

2.2T100s3_IM7_rev02.fm

Note! If there is any risk for liquid spray or rain, extra care must be taken to prevent the water into the cabinet.

7.3.3 Signal and cable details

Note! Recommended cables are to be considered as proposals. The installation engineer is responsible to dimension and specify the type of cable.

1 Grid connection

Recommended cable:	Cu 3 x 95 mm^2 + 70 mm^2

Connect the grid cable to the circuit breaker EAQ1 terminal block and the safety ground on the ground bar. Use cable lugs on both power and ground cables.

2 Heat exchanger water pump (optional)

Recommended cable:	Cu 4 x 1.5 mm^2

The cable is used to feed a water pump whitin the ratings 1.6-2.5 A.

Connect the cable from the heat exchanger water pump to the X1 terminal block connections 1 to 4. Read the rated current value of the water pump motor and set the correct value on the motor overheat protection GC QM4.

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3 Customer water temperature, 3 wire PT100 sensor

Recommended cable:	Cu 3 x 0.75 mm^2 shielded

The temperature can be used by the T100 control system to control the heat output of the T100.

Note! The sensor and about one meter cable is included in the T100 supply.

Connect the cables to the X1 terminal block connections 55 (GND), 56 (PT100+) and 57 (PT100-).

4 Water pump control/Start signal for external heat exchanger water pump (optional)

Recommended cable:	Cu 2 x 1.5 mm^2

The signal is used to start/stop a water pump outside the current ratings 1.6-2.5 A

Connect the cables to the X1 terminal block connections 23 and 24.

5 Customer boiler output temperature (optional)

Recommended cable:	Cu 2 x 0,75 mm^2 shielded

The T100 can read and present a temperature from the customer water system. It is not used for control, only for presentation.

Connect the cables to X1 terminal block connections 58 and 59. The scaling is fixed, 0 to 20mA equals (-25) to (+100) degrees C.

6 Enable main output contactor (optional)

Recommended cable:	Cu 2 x 1.5 mm^2

An external potential free contact can force the T100 main contactor (TAKM02) to open by hardware. A closed loop allows the contactor to close. By default, there is a jumper connected.

Connect the cables to X1 terminal block connections 19 and 20.

7 Main output contactor status (optional)

Recommended cable:	Cu 2 x 1.5 mm^2

A potential free contact inside the T100 indicates if the Main output contactor (TAKM02) is open or closed. This is to be used in case of feedback signal on the 'Enable main output contactor' signal is required.

Connect the cables to the X1 terminal block connections 21 and 22.

8 Grid healthy (optional)

Recommended cable:	Cu 2 x 1.5 mm^2

A potential free contact on external equipment can be used to open/close a circuit inside the T100 which informs the grid side of the power electronics about the grid status. A closed loop indicates that the grid is healthy. By default, there is a jumper connected. Note that this is not opening the main output contactor (TAKM02) by hardware.

Connect the cables to the X1 terminal block connections 13 and 14.

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9 Produced Electrical Energy (optional)

Recommended cable:	Cu 2 x 0,75 mm^2

If an external energy meter is used, the output from this can be fed to the T100 and the measurement will be presented in the T100 remote system. The signal is to be pulses 0/24 V.

Connect the cables to the X1 terminal block connections 41 and 42. The scaling of the input is made in the configuration setup software, see *section 9. Final installation checks*.

10 Site imported electrical active power (optional)

Recommended cable:	Cu 2 x 0,75 mm^2

If the option Load following is used, the active power signal from the watt meter will be connected to this terminal. The signal is a 0-20 mA.
The T100 control system will control the T100 output power based on this signal if so required. Typically, this function is used in cases where an export of power from the site is not allowed or not economically beneficial.

Connect the cables to X1 terminal block connections 62 and 63. The scaling of the input is made in the configuration setup software, see *section 9. Final installation checks*.

11 External T100 Emergency stop (optional)

Recommended cable:	Cu 2 x 1.5 mm^2

An external two pole emergency stop circuit connected in series with the one on the T100 electrical cabinet close to the operators panel.

Connect the cables to the X1 terminal block connections. The first emergency stop contact is to be connected between 05 and 07 and the second/redundant one between 06 and 08.

12 Indicate T100 Emergency stop (optional)

Recommended cable:	Cu 2 x 1.5 mm^2

A potential free contact inside the T100 supplying a feedback signal on the emergency stop circuit status.

Connect the cables to the X1 terminal block connections 11 and 12.

13 BMS: T100 start/stop (optional)

Recommended cable:	Cu 2 x 0,75 mm^2

An external 0/24VDC signal to start/stop the T100 (if BMS control mode is selected). 24V indicates 'Start' and 0V 'Stop'.

Connect the cables to the X1 terminal block connections 51 and 52.

Note! A +24 V is supplied on the X1:17 (+) and X1:19 (GND) which can be used in case the BMS system has a relay output.

14 BMS: Indicate T100 alarm (optional)

Recommended cable:	Cu 2 x 0,75 mm^2

The T100 has a potential free contact indicating if something is wrong with the T100. If an alarm is sent, the T100 has stopped and a manual reset is needed. This is indicated with a closed loop.

Connect the cables to X1 terminal block connections 34 and 35

15 BMS: Indicate T100 running (optional)

Recommended cable:	Cu 2 x 0.75 mm^2

The T100 has a potential free contact indicating that the T100 is in running state or it is above a by configuration specified turbine temperature and speed. This is indicated by a closed loop.

Connect the cables to the X1 terminal block connections 36 and 37.

16 BMS: T100 active power reference (optional)

Recommended cable:	Cu 2 x 0.75 mm^2

There are two alternatives to control the T100 output active power if the BMS control mode is selected.

Alternative 1. An external analogue current signal (0-20 mA).
Connect the cables to the X1 terminal block connections 72 (signal ground) and 73 (0-20 mA analogue input).

Alternative 2. An external analogue voltage signal (0-10 V).
Connect the cables to the X1 terminal block connections 70 (signal ground) and 71 (0-10V analogue input).

The selection and scaling of the input is made in the configuration setup software, see *section 9. Final installation checks*.

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17 BMS: T100 reactive power reference (optional)

Recommended cable:	Cu 2 x 0.75 mm^2

An external analogue (4-20 mA) signal to control the output reactive power of the T100 if the BMS control mode is selected.

Connect the cables to the X1 terminal block connections 67 (T100 signal ground) and 68 (T100 4-20 mA analogue input).

The input 4-20mA corresponds to 0-112 kVAr. Note that the maximum reactive power output can be less in case of high active power output as the maximum apparent power is limited.

18 BMS: External fail (optional)

Recommended cable:	Cu 2 x 0,75 mm^2

An external 0/24VDC to indicate that an external circuit not is OK.
A 24V indicates 'no alarm'.

Connect the cables to the X1 terminal block connections 47 (+24V) and 48 (GND).

Note! A +24V is supplied on X1:17 (+) and X18 (GND) which can be used in case the BMS system has a relay output.

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19 AI Spare 1 (optional)

Recommended cable:	Cu 2 x 0,75 mm^2

Spare analogue input to the T100 control system.

Connect the cables to X1 terminal block connections 60 and 61.

20 AI Spare 2 (optional)

Recommended cable:	Cu 2 x 0.75 mm^2

Spare analogue input to the T100 control system.

Connect the cables to the X1 terminal block connections 72 and 73.

21 AO Spare (optional)

Recommended cable:	Cu 2 x 0.75 mm^2

Spare analogue output from the T100 control system.

Connect the cables to the X1 terminal block connections 31 and 32.

22 +24V to external components (optional)

Recommended cable:	Cu 2 x 1.5 mm^2

A 24 VDC output for small loads to be supplied from the T100 power supply. Absolute maximum 7.5 A can be supplied.

Connect the cables to the X1 terminal block connections 17 (+) and 18 (GND).

23 Phone line

Recommended cable:	

Analogue telephone line to be connected to the T100 modem used by the T100 remote system.

Connect the cable directly to the modem inside the T100 electrical cabinet.

24 Data Network (optional)

Recommended cable:	Ethernet (RJ45 connector)

It is possible to connect the T100 remote system to a data network (LAN) via an Ethernet connection.

Connect the cable directly to the T100 control unit (PMC).

2.2T100s3_IM7_rev02.fm

8. Software configuration

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8.1 Unit configuration

Note! Editing the unit configuration should only be done by authorized personnel. Incorrect settings will void warranty and can seriously damage the turbine unit!

8.2 Parameter description

8.2.1 Document validity

This instruction is valid for use with application: See *section 8.2.12 Software version*, together with EEI power electronic cabinet.

8.2.2 Pin code protection

Configuration is protected by PinCode, if the correct PinCode is not entered, configuration is not possible. When the configuration is done the Pin Code can be deactivated manually or it will be deactivated automatically five minutes after the latest input command.

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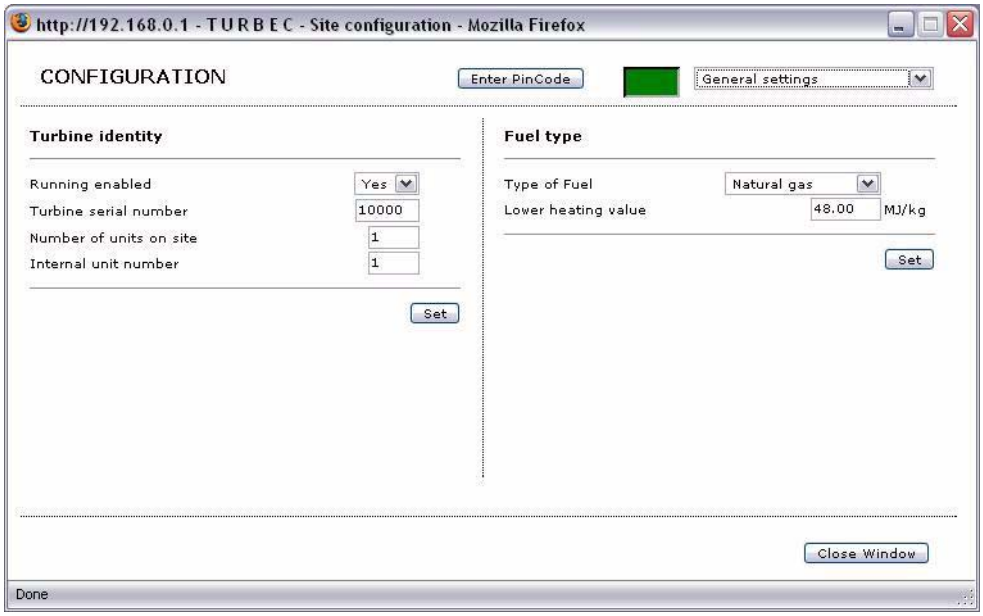
8.2.3 Identity & fuel type - Site identity

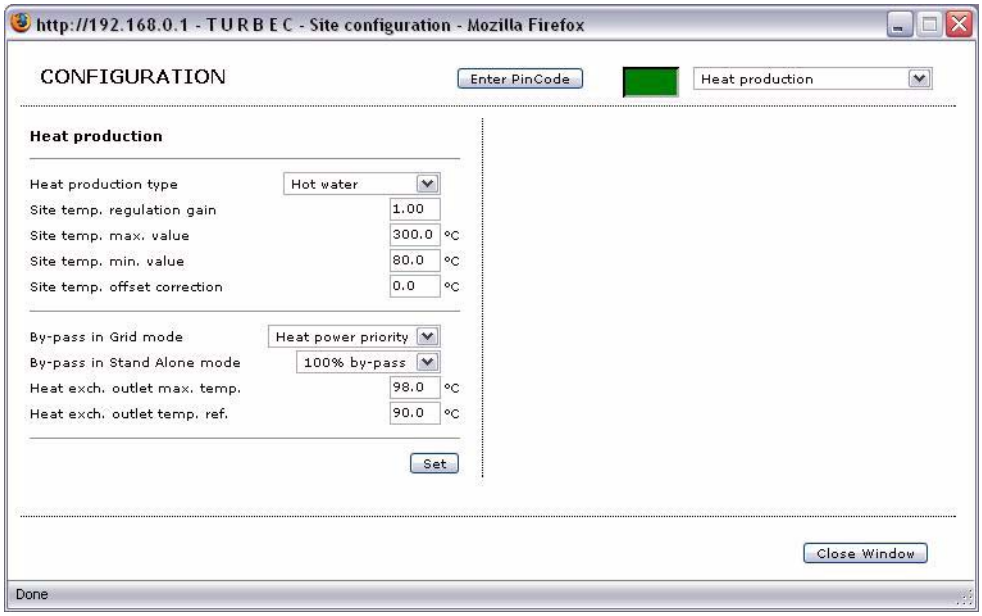


Site identity	Variable	Explanation
Running enabled	(No, Yes)	Used to disable running if for some reason (service or other) the turbine running should be disabled.
Turbine serial number	(10001-)	*Turbine serial number* is used to define the identity of the unit
Number of units on site	(1-10) default = 1	More than one unit can be installed on the site and be connected with a local Ethernet.
Internal unit number	(1-10) default = 1	Is used as unit addresses when the units send data between them. As an example, if the site consists of three units they should be given the internal unit numbers 1, 2 and 3.

8.2.4 Identity & fuel type - Fuel type

Fuel type	Variable	Explanation
Type of fuel	Natural gas, Biogas, Kerosene/Diesel, Methanol default = Natural gas	Specifies the type of fuel used. Type of fuel configuration is used in the turbine control and in some cases also to enable and disable fault conditions.
Lower heating value	[MJ/kg] default = 48	Specifies energy content in fuel. Controls correspondence between calculated amount of fuel and opening degree of the fuel valve. A lower heating value means a wider opening of the fuel valve at a given fuel reference value.

8.2.5 Heat production



Heat production type	Variable	Specifies utilization of heat power.
	Hot water	-Enables trips: *heat exchanger outlet temp high (66)* and *site temperature oor (65)* and *water flow low (6)*.
		-Enables turbine stop on *heat demand low*.
		-Enables temperature control on *heat exchanger outlet temp* and *site temperature*.
		-Changes denomination of *site temperature to site **water** temperature* in remote control web pages.
		-Will display *site temperature* on the control panel as *WaterTemp.*

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Heat production type	Variable	Specifies utilization of heat power.
	Hot exhaust gas	-Disables trips: *heat exchanger outlet temp high (66)* and *water flow low (6).*
		-Enables trip: *site temperature oor (65).*
		-Enables turbine stop on *heat demand low.*
		-Enables temperature control on *site temperature.*
		-Disables temperature control on *heat exchanger outlet temperature.*
		-Heat exchanger by-pass valve is locked to 100% by-pass independent of other settings.
		-Will display *site temperature* on the control panel as *ExhGasTmp*
	Not utilized	-Disables trips: *heat exchanger outlet temp high (66)* and *site temperature oor (65)* and *water flow low (6)*.
		-Disables temperature control on *site temperature* and *heat exchanger outlet temperature*.
		-Heat exchanger by-pass valve is locked to 100% by-pass independent of other settings.
Site temp. regulation gain	default = 1.0	*(Site temperature - site temp reference)*Site temp regulation gain = Site temp regulation error*
		Site temp. regulation gain is used as gain in both speed/power regulation and exhaust gas by-pass valve regulation.
Site temp. max. value	[°C] default = 95	Defines maximum positive *Site temperature.* If this value is exceeded the unit is stopped with the message *heat power demand low*.
		NOTE - *Site temp. max. value* is also used as maximum value limiter for *Site temp reference* (Set from Send Command page)
Site temp. min. value	[°C] default = 80	Defines min temperature for *Site temperature*. The *Site temperature* must be less than this value to allow the unit to start. If the units has been stopped with message *heat power demand low* (see above) the *Site temperature* must go below *Site temp. min.* value before the unit again is allowed to start.
		NOTE - *Site temp. min. value* is also used as minimum value limiter for *Site temp reference*. (Set from Send Command page)
Site temp. offset correction	[°C] default = 0	Will add to s*ite temperature measurement* as an offset.

2.2T100s3_IM7.5_rev02.fm

Heat production type	Variable	Specifies utilization of heat power.
By-pass in Grid mode		Defines eventual use of the heat exchanger by-pass valve. In case of over temperature (*heat exchanger temp* or *site temperature*), generated heat power will be decreased by lowered el. power output (by decrease of turbine speed) or waste of exhaust gas heat (by the use of exhaust gas by-pass valve).
	El. power priority	-Heat exchanger by-pass valve (regulated on *site temp reference* and *heat exch. outlet temp. ref.*) is used before electrical power is decreased.
		-*Site temperature* must go above the mean value of *Site temp reference* and *Site temp*. *max value* or *Heat exchanger outlet water temp* must go above mean value of *heat exch. outlet water temp ref*. and *heat exch. outlet max. temp.* before el. power is decreased
	Heat power priority	-Generated Electrical power (regulated on *site temp reference* and *heat exch. outlet temp. ref.*) is decreased before exhaust gas by-pass valve is used.
		-*Site temperature* must go above the mean value of *Site temp reference* and *Site temp. max value* or *Heat exchanger outlet water temp* must go above mean value of *heat exchanger outlet water temp ref.* and *heat exchanger outlet max. temp*. before exhaust gas by-pass valve is used.
	100% by-pass	Exhaust gas valve is set to full open. Thereby always wasting all heat energy.
	0% by-pass	Exhaust gas valve is set to full closed. Thereby always using all heat energy.
By-pass in Stand-Alone mode(.	default=100% by-pass)	Defines use of *heat exchanger by-pass valve* in case of running during grid failure.
	Site temp. ctrl	Enables temperature control with by-pass valve regulation on *site temperature ref.* and *heat exch. outlet temp. ref.*
	100% by-pass	Exhaust gas valve is set to full open. Thereby always wasting all heat energy.
	0% by-pass	Exhaust gas valve is set to full closed. Thereby always using all heat energy.
Heat exch. max outlet temp.	[°C] default=98	Boiler protection. Defines the trip level of *heat exchanger outlet temp high (66).*

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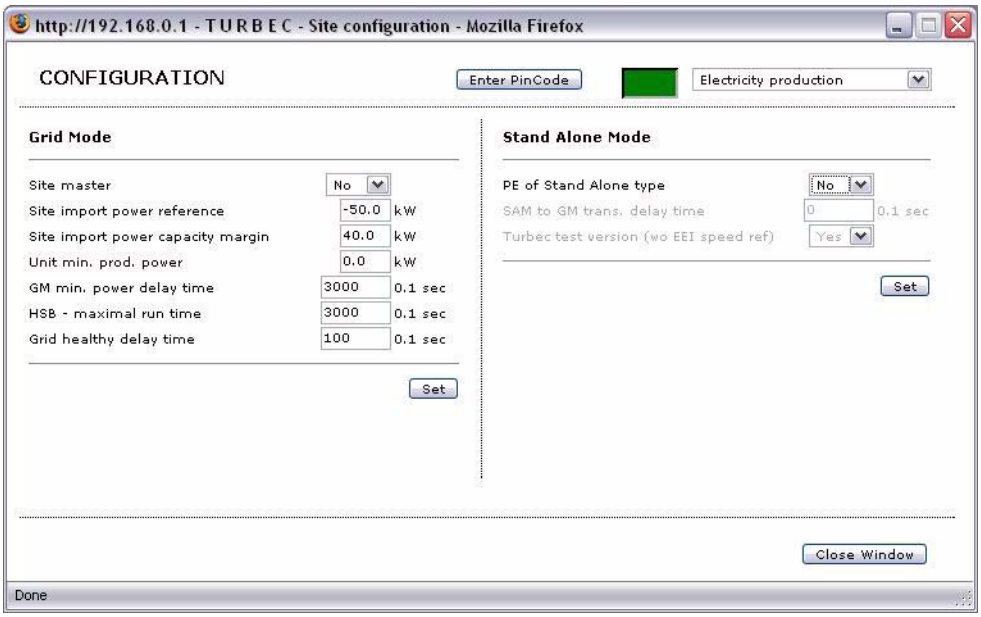
Heat production type	Variable	Specifies utilization of heat power.
Heat exch. outlet temp. ref.	[°C] default=90	The reference temperature of heat exchanger outlet water temperature. Is used to regulate *heat exchanger outlet water temp.* Regulation is done by preferred method, see settings for *By-pass in Grid mode* and *By-pass in Stand Alone mode* above.

8.2.6 Electricity production



Production type	Variable	Explanation
Site master	(No, Yes) default=No	The Site master is responsible for distributing electrical power references to units set in SiteCtrl mode.
		The power reference is calculated using an estimation of required power output. This estimation is distributed to connected SiteCtrl:ed units as Customer electrical power reference. The estimated power is calculated as Site imported power - *Site imported power reference + T100 electrical power output.*
		NOTE - Only one unit in a cluster should be assigned as Site master unit.

Production type	Variable	Explanation
Site import power reference	[kW] default= -50	T100 will try to control the Site imported electrical power to the value of Site import power reference by changing the electrical power output of the T100.
		If the site imports less than the reference value, the T100 power output will be lowered until the difference between the reference value and measured value is zero.
		If the site imports more than the reference value, the T100 power output will be increased until the measured value is equal to the reference or the T100 reach is maximum output power limitation.
		NOTE - If the unit has no site import power measurement it is not possible to put a min power conditional stop of the unit. If there is no import power measurement, to allow running, the following values should be entered.
		Import power reference = -50kW *Unit min prod. power = 0kW*
Site import power capacity margin	[kW] default= 40	This value is used if the unit is configured as Site Master.
		Site import power capacity margin is added to the Cluster power estimation. The sum of the estimated power and the *Site import power capacity margin* is used as base for calculating how many units that shall be put in running condition. The higher this value is, the more units will be put in running condition, and thereby lowering the base load on each unit. If the base load per unit is lower than the prod power at min speed, the Site Master will put units in a Hot Stand By position (units is running with zero power at minimum turbine speed). The reason to use *import power capacity margin* is to increase the capability to react fast on positive load steps.
Unit min. prod. power	[kW] default= 0	Used to define a custom minimum electrical power level. Before the unit is started it will do an estimation of the needed electrical power (estimated power is calculated as Site imported power - *Site imported power reference* + *T100 electrical power output)*. If this estimation is larger than *unit min. prod. power* the unit is allowed to start.
		NOTE - Min power will never be less than the internally estimated min power (estimated power at 75% speed - minimum turbine speed).
		NOTE - this setting needs a valid import power measurement to be functional.

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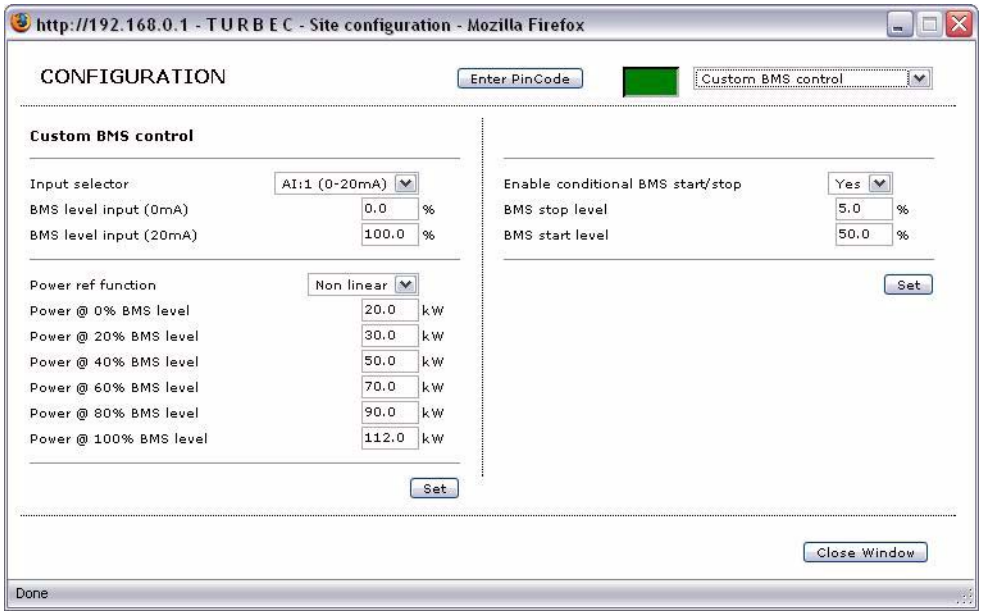
Production type	Variable	Explanation
GM min. power delay time	[0.1 sec] default= 1800	If *electrical power output* is less than *Unit min. prod. Power* for a time that is specified by *GM min*. *power delay tim*e, the unit is stopped.
HSB - maximal run time	[0.1 sec] default= 3000	If the running condition is removed the unit will continue to run in Hot Stand By mode for a time defined *by HSB - maximal run time*. This is only valid for the following start conditions (Grid fault, Grid Mode not enabled, El. power demand low and Removed start condition in SiteCtrl mode).
		NOTE - the unit will not continue to run in Hot Stand By, if the heat demand of the site is considered too low.
Grid healthy delay time	[0.1 sec] default= 0	If there is connected an external relay protection, this might have a written regulation that defines that grid has to be continuously ok for a period of time before grid is defined healthy. To make sure the internal logics of the turbine has the same definition of grid healthy as the relay protection an appropriate value should be entered for *Grid healthy delay time.*
		Example - G59 standard of GB says grid should be healthy for 90 sec, the same value or slightly more should be entered as parameter for *Grid healthy delay time*.

8.2.7 Custom BMS control



In control mode BMS, Electrical power reference is directly controlled by an analog input PMC-AI:1 (current) or PMC-AI:2 (voltage). Current or Voltage input selection is done with Input selector.
Electrical power reference can be controlled linear or non linear to the analog input. Start and stop can be trigged by changes in the BMS input signal..

Control type	Variable	Explanation
Input selector	[AI:1 (0-20mA) / AI:2 (0-10V)] default=AI:1(0-20mA)	Select current or voltage mode for BMS level input. AI:1 is connected to X1:71-X1:70, AI:2 is connected to X1:73-X1:72.
		NOTE - hardware connection must correlate with setting of Input selector.
BMS level input (0mA)	[%] default=0	BMS level at 0mA input signal
BMS level input (20mA)	[%] default=100	BMS level at 20mA input signal
Power ref function	[non linear / linear] default=non linear	Linear means that electrical power reference is linear to the analog input.
		By selecting Non linear the power reference can be selected to be Non linear (user defined) to the analog input.
Power @ 0% BMS level	[kW] default=20	Electrical power reference at 0% BMS level.
Power @ 20% BMS level[	kW] default=30	Electrical power reference at 20% BMS level (only active for non linear power ref function).
Power @ 40% BMS level	[kW] default=50	Electrical power reference at 40% BMS level (only active for non linear power ref function).
Power @ 60% BMS level	[kW] default=70	Electrical power reference at 60% BMS level (only active for non linear power ref function).
Power @ 80% BMS level	[kW] default=90	Electrical power reference at 80% BMS level (only active for non linear power ref function).

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Control type	Variable	Explanation
Power @ 100% BMS level	[kW] default=112	Electrical power reference at 100% BMS level.
Enable conditional BMS start/stop	[no / yes] default=no	By selecting yes, the unit can be stopped and started trigged by changes in the BMS level input.
		NOTE - All start conditions (Customer start signal, BMS Start Switch etc.) has to be true to enable start of the unit.
BMS stop level		If BMS level is below the BMS stop level the unit is stopped (only active if Enable conditional BMS start/stop is set to yes).
BMS start level		If BMS level is above the BMS start level the unit is allowed to start (only active if Enable conditional BMS start/stop is set to yes).

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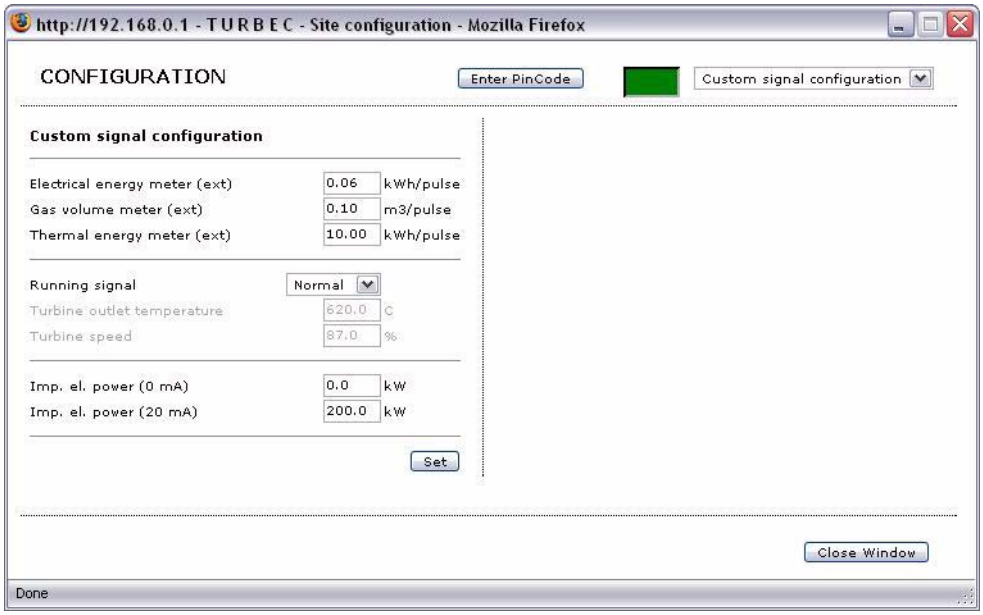
8.2.8 Custom signal configuration



Signal type	Variable	Explanation
Electrical energy meter (ext.)	[kWh/pulse] default=0.06	The amount of produced electrical energy per pulse if customer has own electrical pulse energy meter (connected to PMC DI:16).
Gas volume meter (ext.)	[m^3/pulse] default=0.10	The amount of used gas volume per pulse if customer has own pulse meter for consumed gas (connected to SCC DI:13).
Thermal energy meter (ext.)	[kWh/pulse] default=10	The amount of produced thermal energy per pulse If customer has own pulse meter for produced thermal energy (connected to SCC DI:14).
Running signal	default=Normal	Is used to configure the PMC DO:7 signal *Turbine running*. User can choose between normal and custom running signal.
	Normal	*Turbine running* signal is set when state machine reach running state (11)
	Custom	*Turbine running* signal is set when *Turbine outlet temperature* and *Turbine speed* is over the specified limits (see below).
Turbine outlet temperature	[°C] default= 620	Limit for *Turbine outlet temperature* if Running signal is set to Custom
Turbine speed	[%] default= 87	Limit for *Turbine speed* if Running signal is set to Custom
Imp. el. power (0mA)	[kW] default= 0	Configurable range (0mA value) for imported electrical power meter.
Imp. el. power (20mA)	[kW] default= 200	Configurable range (20mA value) for imported electrical power meter.

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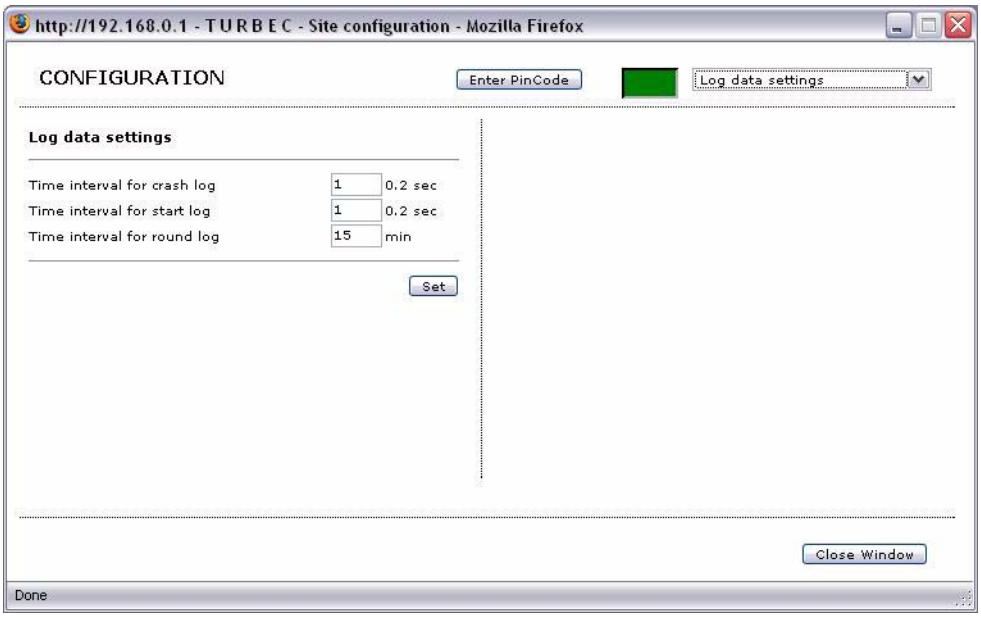
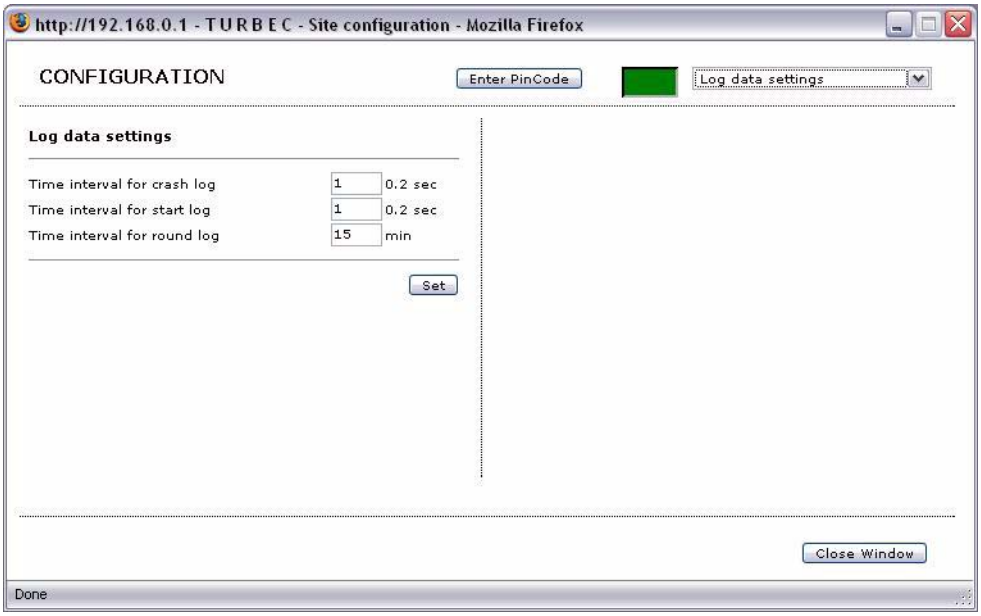
8.2.9 Statistical data



Data type	Variable	Explanation
Prod electrical energy	[kWh]	Initiation of produced electrical energy, internal
		NOTE - the internal measurement is an estimation of the produced electrical energy based on active power output measurement. It should not be used for debit purpose.
Operation time	[h]I	Initiation of operation time
Number of starts		Initiation of start counter
Prod. electrical energy (ext.)	[kWh]	Initiation of produced electrical energy meter, external (not standard)
Consumed gas volume (ext.)	[m^3]	Initiation of gas volume meter, external (not standard)
Prod. thermal energy (ext.)	[kWh]	Initiation of produced thermal energy meter, external (not standard)

8.2.10 Log data settings



Setting type	Variable	Explanation
Interval for crash log	[0.2 sec] default=1	The time interval between two sample points in the internal crash log
Interval for start log	[0.2 sec] default=2	The time interval between two sample points in the internal start log
Interval for crash log	[min] default=30	The time interval between two sample points in the internal round log

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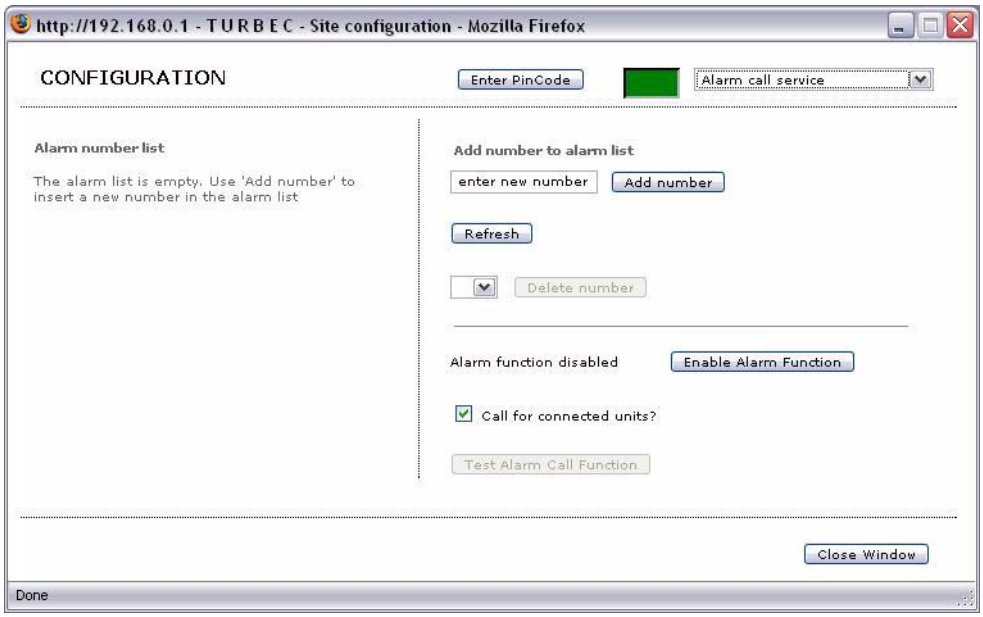
8.2.11 Alarm call service



If the unit has an active alarm the unit can be configured to dial a telephone number (or multiple numbers).

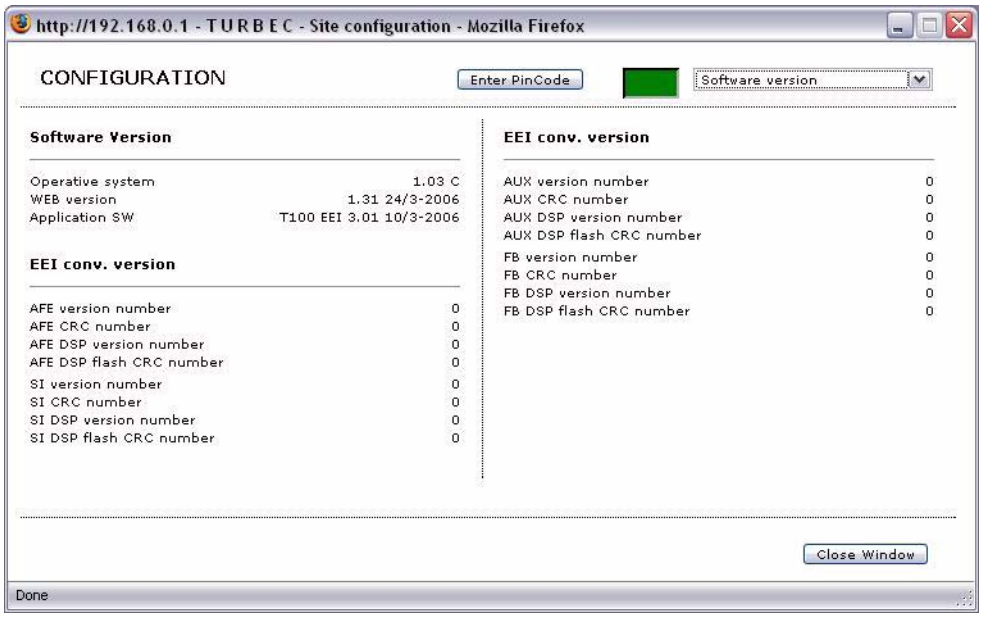
Note that the alarm call will not be made for an alarm that only creates a restart of the unit. Alarm calls are made if the unit requires a manual reset to restart.

The unit will do alarm calls with the following intervals;

1:st call	Directly
2:nd call	60 minutes after alarm trig
Following calls	Every 24 hours

Alarm number list	The unit will call telephone numbers in the alarm list according to entered order, starting with number 1.
Add number to alarm list	Use the field 'Enter new number' to write a new telephone number.
	Use button 'Add number' to confirm adding of the entered telephone number
	The telephone number can consist of up to 5 zeros before the number.
	You may use the plus sign (+) in front of the number.
	The maximal telephone number length (excluding pre number dialled zeros) is 16 signs.
Delete number	Use the drop down menu and button 'Delete number' to select a number to delete from the alarm number list.
Enable/Disable Alarm Function	Enable or disable the alarm call functionality using the 'Enable/Disable Alarm Function' button.
Call for connected units?	If the unit with the modem is part of a T100 multiple unit site, one unit can be configured to do alarm phone call for all units.
	Note - Only the unit with the modem shall be configured to do alarm phone call.
Test Alarm Call Function	Will trig a telephone call to all numbers that has been entered in the alarm list.

8.2.12 Software version


http://192.168.0.1 - TURBEC - Site configuration - Mozilla Firefox
CONFIGURATION
Enter PinCode
Software version
Software Version
Operative system 1.03 C
WEB version 1.31 24/3-2006
Application SW T100 EEI 3.01 10/3-2006
EEI conv. version
AFE version number 0
AFE CRC number 0
AFE DSP version number 0
AFE DSP flash CRC number 0
SI version number 0
SI CRC number 0
SI DSP version number 0
SI DSP flash CRC number 0
EEI conv. version
AUX version number 0
AUX CRC number 0
AUX DSP version number 0
AUX DSP flash CRC number 0
FB version number 0
FB CRC number 0
FB DSP version number 0
FB DSP flash CRC number 0
Close Window
Done

Operative system	Version number of PMC operative system.
WEB version	Version of WEB. Presented by version number and compile date.
Application SW	Version number of T100 software application.

8.2.13 Test Mode

For Turbec use only.

9. Final installation checks

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9.1 Installation and connection checks

See *section 6. Mechanical installation and connection*, and *section 7. Electrical installation* for further details on the following checks.

No.	Checks	Done
1	The T100 microturbine is level transversely and longitudinally (± 1 mm/m)	
2	The exhaust gas pipe system is connected/positioned	
3	The fuel gas evacuation pipe system is connected/positioned. The gas-outlet is a gasZone 1 area and only equipment with appropriate certifications are to be located within this area (see *section 2. Safety precautions*).	
4	The hot water pipe system is secure -ventilate the exhaust gas heat exchanger -hot water inlet -hot water outlet	
5	The fuel gas system is secure: -fuel gas inlet	
6	The electrical cables are correctly connected to the: - grid - evacuation fan - water circulating pump (T100PH) - temperature sensor (T100PH) - by pass motor power (optional) (T100PH) - start battery cables (T100PS) - telephone / computer network - extra wall mounted emergency stop (optional) - power metering (optional) - BMS (optional)	
7	Upstream valves/switches are open/on: - electrical power - re-circulating hot water supply and return (T100PH) - fuel gas	
8	Ventilate water circuit of the exhaust gas heat exchanger (T100PH)	
9	Make sure the T100 is installed in a non hazardous area (see *section 2. Safety precautions*)	
10	Make sure that the evacuation fan is installed according to instruction in the Installation manual	

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9.2 Lubrication and water level check

See the *Operator's manual* and the *Maintenance manual* for further details on the following checks.

No.	Checks	Done
1	Lubrication system	
2	Water cooling system	

9.3 Safety checks

No.	Checks	Done
1	Make sure that all the T100 microturbine doors open and close correctly	
2	Make sure that all removable doors and covers are secure	
3	Make sure that the **Emergency stop** button engages and releases correctly. If the test is made on a running T100, make this test on a "cold" T100 and at low power to minimize the risk of lifetime reduction.	
4	Turbec recommends purging the fuel gas system with helium from the end of the gas grid to the safety valve in front of the T100 microturbine. Detect possible leaks with a gas sniffer	
5	Turbec recommends to purge the fuel gas system with nitrogen from the inlet side of the fuel gas compressor to the safety valve in front of the T100 microturbine to avoid an explosive mixture of air and natural gas	
6	Make sure that the rotation direction of the evacuation fan is correct	
7	Make sure that rotation direction of the water circulating pump is correct	

9.4 Start-up

No.	Checks	Done
1	Prepare the T100 microturbine for production. See Operator's manual for further details.	
2	Check and modify the T100 configuration set-up in the PMC:	

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10. Preparation for commissioning

2.2T100s3_IM9_rev02.fm

Perform the following checks even if an actual commissioning test is not required.

Note! Commissioning covers only the functioning of the individual machine. A line performance test is required to check the functioning of the T100 microturbine as part of a complete line and part of a cluster installation. Check with the local service organization about arrangements for a line performance test or a cluster installation

10.1 Presence and correctness checks

No.	Checks	Done
1	The data on the machine identification sign corresponds with the specification in the Machine specification document	
2	The required spare parts have been delivered and have been deposited in the spare part store	
3	All the documents correspond to the specific T100 microturbine: - Operator's manual - Maintenance manual - Installation drawings - Factory acceptance test report - Machine specification document - Machine deviation report (if relevant)	
4	The fuel gas and the water quality is sufficient for commissioning purposes	
5	The keys for the doors are present	

10.2 Supply value checks

No.	Checks	Done
1	Fuel gas supply: - Quality - Pressure - Max pressure fluctuation - Inlet temperature	
2	Electrical power supply: - Voltage - Max voltage fluctuation - Frequency - Fuse rating	
3	Water supply (T100PH): - Quality - pH - Pressure - Max pressure fluctuation - Inlet temperature	

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10.3 Function checks

10.3.1 Preparation

a) Check the oil level of the oil tank in the T100 microturbine.

b) Check that all manual gas valves are open between the gas grid and the T100 microturbine.

c) Check all manual cut-off valves, water coil in exhaust gas heat exchanger are open.

d) Switch on the isolating switch outside the T100 and the T100 main circuit breaker on the electrical cabinet.

e) Press **"Start"** on the control panel on the T100 microturbine.

f) Wait for status displayed on control panel.

No.	Checks	Done
1	Electrical output displayed on control panel is as specified	
2	There are no unusual noises which could indicate misaligned parts or faults	
3	There are no unusual smells which could indicate internal leaks or burning electrical circuits	
4	All pressures remain within tolerances, see operator's manual	

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10.4 Health and safety checks

No.	Checks	Done
1	The T100 microturbine stops when the **Emergency stop** button is pressed If the test is made on a running T100, make this test on a "cold" T100 and at low power to minimize the risk of lifetime reduction.	
2	The T100 microturbine stops when the doors open	
3	The T100 microturbine stops when the **Stop** button is pressed	

10.5 Documentation

Note! No claims will be accepted for equipment in production if the **Start-up machine quality report** *(see section 12. Appendix: Start-up machine quality report)* has not been returned to the manufacturer. Receiving the Start-up machine quality report will issue letter of acceptance.

If no damage occurred during transport, write "*No transport damage*"

a) Compile the **Start-up machine quality report**.
List all work, besides the installation work that was performed to ensure correct functioning.

The installation work covered by this manual is now complete.

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11. Disassembly and removal

2.2T100S3_IM10_rev02.fm

11.1 Draining - T100 PH

Caution! If the T100 PH/PHS microturbine is going or standing or travelling in cold conditions, the water circuit in the exhaust gas heat exchanger must be drained to avoid damage by freezing.

The T100 PH/PHS microturbine can be moved **short distances** without being drained or completely disassembled, but only if **no freezing** conditions will be encountered. The exhaust gas heat exchanger must be drained before long distance moves or longtime storage. If draining is necessary, drain the T100 PH microturbine before disassembling.

11.1.1 Draining procedure

To drain the exhaust gas heat exchanger, a standard set of tools and a tray for the expelled water are required.

a) Switch off the T100 PH microturbine.

b) Shut off the valves for inlet and outlet to the external hot water system.

c) If possible drain the remaining hot water system, including the exhaust gas heat exchanger outside the T100 PH microturbine.

WARNING!

Risk of injury and damage!
Make sure that the water expelled from the exhaust gas heat exchanger cannot cause injury or damage for personnel and equipment.

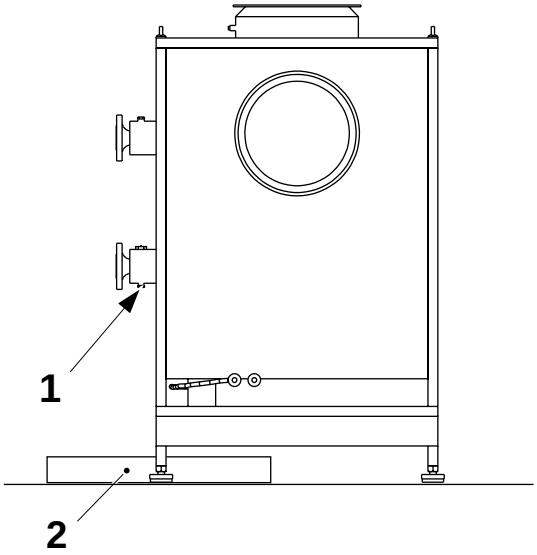
(Continued)

(Continued)

d) Put a tray (2) under the draining plug (1) located on the outlet side of the heat exchanger.

e) Open the draining plug (1) using a holding-on tool and let the water flow out.

1. Draining plug
2. Tray



f) Close the draining plug when the water has stopped flowing.

g) When the water inside the system is drained, disconnect the exhaust gas heat exchanger from the external water heating system.

Note! If the exhaust gas heat exchanger is to be stored a longer time, make sure that it is dry or the remaining liquid is a water-soluble anti-rust agent.

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11.2 Moving the T100 microturbine

11.2.1 Short moves and short term storage

DANGER!

Risk of electrocution!
High voltage. Follow the Safety precautions.

See *section 6. Mechanical installation and connection* and *section 7. Electrical installation* for further details on the following operations.

To disassemble parts, follow the assembly instruction in the reverse order.

11.2.1.1 Preparation for moving

a) Shut off all the terminal supply upstream of the T100 microturbine:
   - electrical power
   - fuel gas
   - water

b) Disconnect the following connections:
   - power
   - fuel gas
   - fuel gas evacuation
   - ventilation outlet
   - water inlet
   - air inlet
   - hot water outlet
   - exhaust gas outlet

c) Plug or protect all open connections.

d) Move the T100 microturbine to its new position.

Caution! Level the T100 microturbine roughly, even if it is not going to be used. If the T100 microturbine is not supported evenly by all its feet, the frame could be subjected to damaging torsional forces.

e) Level the T100 microturbine roughly.

f) Cover the T100 microturbine with suitable protective covering.

g) Make sure that the storage conditions comply with the specifications, see *section 5.6 Moving and Storage*.

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11.2.2 Long moves and long term storage

See *section 5.6 Moving and Storage* operations.

To disassemble parts, follow the assembly instruction in the reverse order.

a) Drain the T100 microturbine, see *section 11.1 Draining - T100 PH*.

b) Perform the operations listed in *section 11.2.1 Short moves and short term storage*, as far as step c).

c) Tape together all the electrical cables to the side of the T100 microturbine.

d) Wrap all loose components in bubble wrapping to prevent damage.

e) Tighten the transport locking devices, see *section 6.3 Release transport locking device* to find their positions, follow the release instruction in the reverse order.

f) Pack the equipment in suitable crates. Use original crates and packing if possible. Make sure that all groups and components are adequately protected.

g) Fix any loose sub-crates or boxes to the floors or walls of the crates to prevent them moving during transport.

h) Move the T100 microturbine to its new position.

Caution! Level the T100 microturbine roughly, even if it is not going to be used. If the T100 microturbine is not supported evenly by all its feet, the frame could be subjected to damaging torsional forces.

i) Level the T100 microturbine roughly.

j) Cover the T100 microturbine with suitable protective covering.

k) Make sure that the storage conditions comply with the specifications, see *section 5.6 Moving and Storage*.

11.3 Return to the manufacturer

a) Prepare the equipment for transport, see *section 11.1 Draining - T100 PH*.

b) Contact the local service organisation for further instructions to arrange shipment.

11.4 Disposal

If the equipment is to permanently disposed of, perform the following operations.

a) Drain the equipment, see *section 11.1 Draining - T100 PH*.

b) Drain the lubrication tank and dispose the lubrication fluid in compliance with local regulations. See Maintenance manual *5.1 Change oil and oil filter*.

c) Drain the water cooling system and dispose of the water in compliance with local regulations. See Maintenance manual *6.1 Change cooling water*.

DANGER!

Powerful magnetic field
The rotor in the engine is a very strong permanent magnet. Keep away from pacemakers, electronic devices and magnetic storage media.

d) Disassemble the equipment as far as possible and separate the following parts and materials:

- stainless steel
- cast iron (frame)
- rubber (seals, O-rings, etc.)
- nylon and other plastics
- electrical cables
- lubrication and water hoses
- electrical components
- engine

Note! Do not separate the engine parts to access the rotor. Return the engine to Turbec for disposal.

e) Recycle or dispose of all materials, groups and components in compliance with local regulations.

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12. Appendix: Start-up machine quality report

2.2T100s3_IM11_rev02.fm

Fax to: Turbec, Malmö Sweden
Fax No: +46 (40) 680 00 01

From (Company):.....

Start-up machine quality report for Machine No:

.....

12.1 Transport damage report

See *section 5.5.1 Inspection of crates* and *section 5.9 Inspection* for further details on the following checks.

Note! If any damage has occurred during transport to installation site, please also report this immediately to Turbec's shipping department.

No.	Checks	Done
1	Crate A was delivered without visible damage	
2	Crate B was delivered without visible damage	
3	Crate C was delivered without visible damage	
4	Crate D was delivered without visible damage	
5	Crate E was delivered without visible damage	
6	Crate F was delivered without visible damage	
7	Crate G was delivered without visible damage	
8	- T100 microturbine was delivered without visible damage - Induced draft fan was delivered without visible damage - Combustion and ventilation air inlet filter (optional)	

(Continued)

12.2 Installation and connection report

See *section 9. Final installation checks* for further details on the following checks.

No.	Checks	Done
1	The T100 microturbine is level transversely and longitudinally ± 1mm/m	
2	The exhaust gas pipe system is connected/positioned	
3	The fuel gas evacuation pipe system is connected/positioned at least 3 m from ignition source	
4	The hot water pipe system is secure: -water inlet -hot water outlet	
5	The fuel gas system is secure: -fuel gas inlet	
6	The electrical cables are correctly connected to the: - grid - induced draft fan - water circulating pump - fuel gas compressor - temperature sensor - telephone / computer network - extra wall mounted emergency stop (optional) - power metering (optional) - local remote (optional)	
7	Upstream valves/switches are open/on: - electrical power - re-circulating hot water supply and return - fuel gas	
8	Ventilate water circuit of the exhaust gas heat exchanger	

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12.3 Lubrication and water level report

See the *Operator's manual* and the *Maintenance manual* for details on these checks.

No.	Checks	Done
1	Lubrication system	
2	Water cooling system	

12.4 Safety report

No.	Checks	Done
1	Make sure that all the T100 microturbine doors open and close correctly	
2	Make sure that all removable doors and covers are secure	
3	Make sure that the **Emergency stop** button engages and releases correctly	
4	Make sure that rotation direction of the evacuation fan is correct	
5	Make sure that rotation direction of the water circulating pump is correct	
6	Make sure that the T100 is installed in a non-hazardous area.	

12.5 Presence and correctness checks

No.	Checks	Done
1	The data on the machine identification sign corresponds with the specification in the order information.	
2	All the documents correspond to the specific T100 microturbine: - Operator's manual - Maintenance manual - Installation drawings - Factory acceptance test report - Machine specification document - Machine deviation report (if relevant)	
3	The fuel gas and the water quality is sufficient for commissioning purposes	
4	The keys for the doors are present	

12.6 Supply value report

No.	Checks	Done
1	Fuel gas supply: - Quality - Pressure - Max pressure fluctuation - Inlet temperature	
2	Electrical power supply: - Voltage - Max voltage fluctuation - Frequency - Fuse rating	
3	Water supply: - Quality - pH - Pressure - Max pressure fluctuation - Inlet temperature	

12.7 Function report

No.	Checks	Done
1	Electrical efficiency displayed on control panel is as specified	
2	There are no unusual noises which could indicate misaligned parts or faults	
3	There are no unusual smells which could indicate internal leaks or burning electrical circuits	
4	All pressures remain within tolerances, see Operator's Manual	

12.8 Health and safety checks

No.	Checks	Done
1	The T100 microturbine stops when the **Emergency stop** button is pressed	
2	The T100 microturbine stops when the doors open	
3	The T100 microturbine stops when the **Stop** button is pressed	

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